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HOSKINS-WESTERN-SONDEREGGER INC LINCOLN NE
NATIONAL DAM SAFETY PROGRAM. WELLINGTON - NAPOLEON WATERSHED ST--ETC(U)
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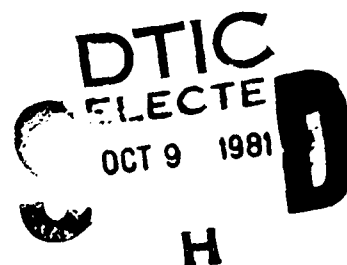
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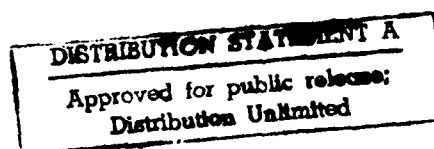
WELLINGTON-NAPOLEON WATERSHED STRUCTURE C-21
LAFAYETTE COUNTY, MISSOURI

MO 10284



PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM

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PREPARED BY: HOSKINS-WESTERN-SONDEREGGER, INC.
FOR: STATE OF MISSOURI

SEPTEMBER, 1978

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Wellington-Napoleon Watershed Structure C-21 Dam
(Mo. 10284) Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Wellington-Napoleon Watershed Structure C-21 Dam:

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- 1) Spillway will not pass 50 percent of the Probable Maximum Flood.
- 2) Overtopping could result in dam failure.
- 3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY:

SIGNED

Chief, Engineering Division

12 APR 1979
Date

APPROVED BY:

SIGNED

Colonel, CE, District Engineer

13 APR 1979
Date

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PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Wellington-Napoleon Watershed Structure C-21
State Located	Missouri
County Located	Lafayette County
Stream	Tributary to Missouri River
Date of Inspection	September 15, 1978

Wellington-Napoleon Watershed Structure C-21 was inspected by an interdisciplinary team of engineers, ~~from Hoskins-Western-Sonderregger, Inc.~~ The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

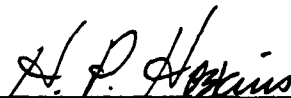
The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. Failure would threaten life and property. The estimated damage zone extends one mile downstream of the dam. Within the first one-half mile downstream of the dam are four to five houses, a Missouri-Pacific railroad crossing and a Highway 24 crossing.

Our inspection and evaluation indicates that the spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Because of the number of houses and the railroad and highway crossings within the first one-half mile downstream of the dam the spillways should be capable of passing the probable maximum flood without overtopping the dam and possibly causing failure of the dam. The spillways will pass a 100-year flood (flood having a one percent chance of being exceeded in any one year) without overtopping the dam. The spillways will also pass 40% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

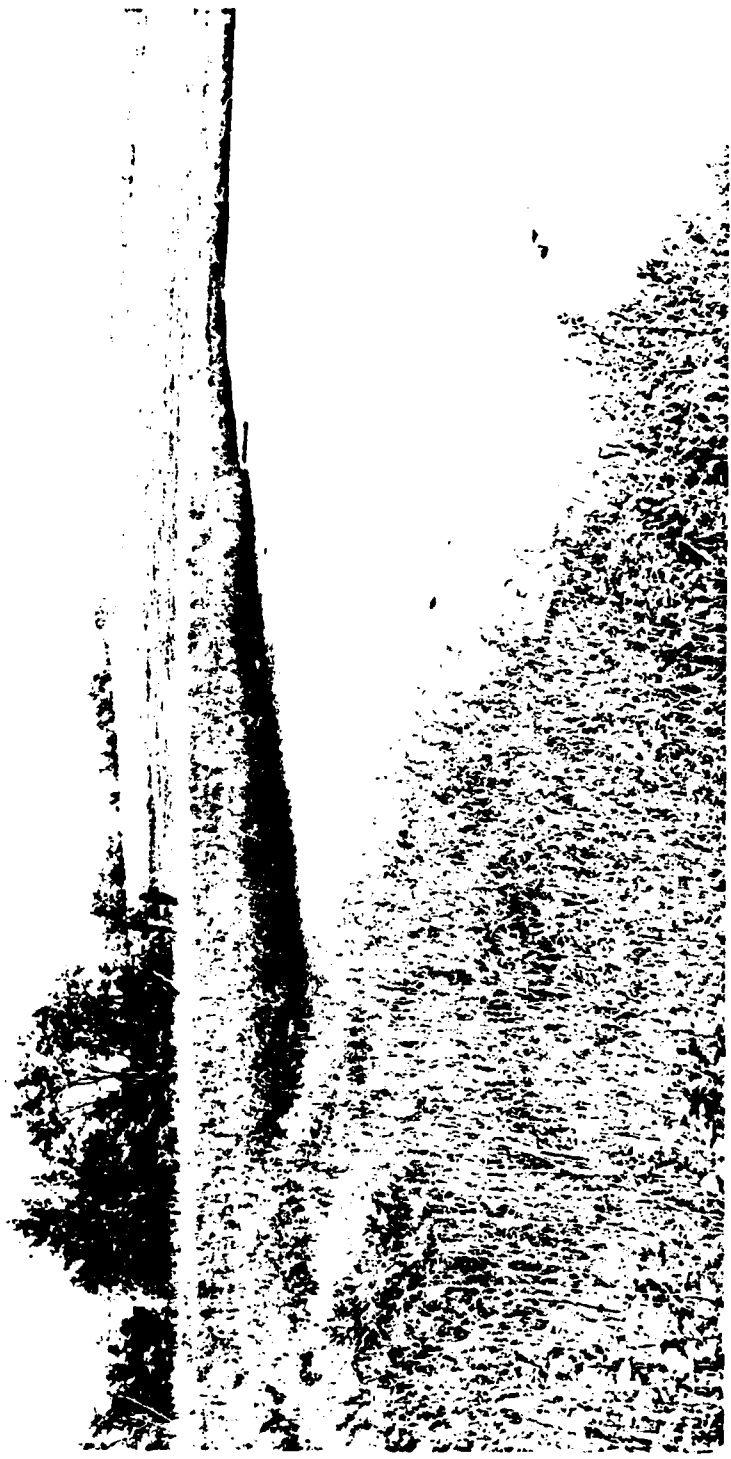
Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These analyses should be obtained in the future.

Other deficiencies visually observed by the inspection team were several rather large rodent holes in the upstream slope, seepage outcropping in both left and right abutment/embankment groins approximately eight feet above principal spillway outlet, and some erosion near the outlet end of the emergency spillway.

Several items of preventive maintenance need to be initiated by the owner. These are described in detail in the body of the report.



Harold P. Hoskins, P.E.
Hoskins-Western-Sonderegger, Inc.
Lincoln, Nebraska



PHOTOGRAPH NO. 1
OVERVIEW TAKEN
FROM LEFT SIDE

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
WELLINGTON-NAPOLEON WATERSHED STRUCTURE C-21
ID NO. MO. 10284

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Sheet 11 of 12	Flow Over Embankment
Sheet 12 of 12	Total Rating

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

- a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Wellington-Napoleon Watershed Structure C-21 be made.
- b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.
- c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed with the help of several Federal agencies and many State agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

- a. Description of Dam and Appurtenances.
 - (1) The Wellington-Napoleon Watershed Structure C-21 is a rolled earth fill approximately 465 feet in length with maximum height of 37 feet. The dam is constructed in the Missouri River loess hills.
 - (2) The principal spillway is uncontrolled and consists of a reinforced concrete (R/C) riser with a 24 inch diameter R/C pipe conduit outlet.
 - (3) The emergency spillway is a vegetated channel cut into loess soils on the left (west) abutment. It has a bottom width of 70 feet and side slopes of 3H on 1V.
- b. Location. The dam is located in the northwestern portion of Lafayette County, Missouri, as shown on Plate 2. The dam is shown on Plate 1 in the SE 1/4 of Section 19 and the SW 1/4 of Section 18, T50N, R28W. The lake formed by the dam is shown on Plate 1 in the previously mentioned 1/4 sections as well as the NW 1/4 of Section 29, T50N, R28W.

- c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, this dam and impoundment is in the small size category.
- d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph c above. Based on referenced guidelines, this dam is in the High Hazard Classification. The estimated damage zone extends one mile downstream of the dam. Within the first one-half mile downstream of the dam are four to five houses, a Missouri-Pacific railroad crossing and a Highway 24 crossing.
- e. Ownership. The dam is owned by the Wellington-Napoleon Watershed Subdistrict, 120 West 19th Street, Higginsville, MO 64037. Attention: Chester Temple, Chairman.
- f. Purpose of Dam. The dam was constructed as a grade stabilization, sediment detention and flood water retarding structure.
- g. Design and Construction History. The dam was constructed in 1969. The design and plans for construction were prepared by the Soil Conservation Service (SCS), Columbia, Missouri. Portions of these data are included with this report as Appendix C.
- h. Normal Operating Procedure. There are no operating facilities for this dam. The lake level is controlled by rainfall, runoff, evaporation and the capacity of the spillway.

1.3 PERTINENT DATA

- a. Drainage Area - 333 acres (0.52 sq. mi.)
- b. Discharge at Damsite.
 - (1) All discharge at the damsite is through an uncontrolled reinforced concrete box drop inlet and reinforced concrete pipe principal spillway and a grassed earth channel ungated emergency spillway.
 - (2) Estimated maximum flood at damsite - unknown.
 - (3) The principal spillway capacity varies from 0 c.f.s. at elevation 758.0 feet to 56 c.f.s. at the crest of the emergency spillway (760.5 feet).

- (4) The principal spillway capacity at maximum pool elevation (763.6 feet) is 60 c.f.s. Maximum pool elevation is that design value for freeboard pool level as furnished on SCS as-built plans.
- (5) The emergency spillway capacity at maximum pool elevation is 1,000 c.f.s.
- (6) The total spillway capacity at maximum pool elevation is 1,060 c.f.s.

c. Elevation (Feet Above M.S.L.).

- (1) Top of dam - 765.0 (SCS plans) - 764.7 (survey 15 September 1978). The settled top of dam as planned by SCS is 763.6.
- (2) Principal spillway crest - 758.0 (SCS plans) - 757.8 (survey 15 September 1978).
- (3) Emergency spillway crest - 760.5 (SCS plans) - 760.5 (survey 15 September 1978).
- (4) Streambed at center line of dam - 728 \pm .
- (5) Maximum tailwater - unknown.

d. Reservoir. Length of maximum pool - 3800 feet \pm .

e. Storage (Acre-feet).

- (1) Top of dam - 297 \pm .
- (2) Emergency spillway crest - 196.
- (3) Principal spillway crest - 150.

f. Reservoir Surface (Acres).

- (1) Top of dam - 29 \pm .
- (2) Emergency spillway crest - 20.2.
- (3) Principal spillway crest - 16.5.

g. Dam.

- (1) Type - Earth embankment.
- (2) Length - 465 feet \pm .
- (3) Height - 37 feet \pm .

- (4) Top width - 14 feet.
- (5) Side Slopes.
 - (a) Downstream - 2.5H on 1V.
 - (b) Upstream - 2.5H on 1V with 20 foot berm at principal spillway elevation.
- (6) Zoning - None shown on the plans.
- (7) Impervious Core - All embankment material reported to be lean clay (CL) as shown in Appendix C.
- (8) Cutoff - Plans show a cutoff varying in depth from 4 to 10 feet with 12 foot bottom width and side slopes of 1H on 1V.
- (9) Grout Curtain - None.
- (10) Drains - None.
- (11) Wave Protection - Vegetated berm.
- h. Diversion and Regulation - None.
- i. Spillways.
 - (1) Principal.
 - (a) Type - Standard SCS 2' x 6' x 10' R/C drop inlet and a 24-inch R/C pressure pipe.
 - (b) Length of weir - 12 feet (2 x 6')
 - (c) Crest elevation - 758.0 feet M.S.L.
 - (2) Emergency.
 - (a) Type - Standard SCS grassed earth channel.
 - (b) Control section - 70 foot bottom width, 3:1 side slopes, 30 feet length.
 - (c) Crest elevation - 760.5 feet M.S.L.
 - (d) Upstream channel - clear and well grassed (tall).
 - (e) Downstream - clear and well grassed (tall).
- j. Regulating Outlets - None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Data on the geologic investigation, hydraulic/hydrologic computations, construction plans, and the soil mechanics/soil engineering report were supplied by the Soil Conservation Service, Columbia, Missouri. This information is shown in Appendix C and Appendix D.

2.2 CONSTRUCTION

No construction data were readily available; however, it is reported that the dam was constructed with SCS engineering supervision and standard inspection and quality control procedures.

2.3 OPERATION

No information was available on the maximum loading on the dam.

All spillways are uncontrolled.

2.4 EVALUATION

- a. Availability. The engineering data shown in Appendix C was readily available from the SCS, Columbia, Missouri.
- b. Adequacy. The available data and reported information are considered adequate to assess the design and stability of the structure. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.
- c. Validity. The available data and analyses conform with accepted practice. Parameters for embankment strength were based upon conservative values obtained from detailed testing of similar (loess) materials used to construct similar embankments in the same watershed.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

- a. General. A visual inspection of Wellington-Napoleon Watershed Structure C-21 was made on September 15, 1978. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska making the inspection were: Rey S. Decker, Geology and Soil Mechanics; Garold Ulmer, Civil Engineer; Richard Walker and Gordon Jamison, Hydrology. Results of the inspection are summarized below. Photographs are shown in Appendix B.

- b. Dam. Rough measurements of the profile along the crest of the dam and emergency spillway and cross sections of the embankment and spillway indicate that the structure was constructed according to the plans shown in Appendix C.

The dam is covered with an excellent growth of adapted grasses and legumes.

No cracks, slides or abnormal deformations were noted on the embankment or abutments.

No significant erosion was noted on the upstream face of the dam. However, several rather large rodent holes were observed on the upstream slope.

Surface materials in the dam and abutments consist of lean clays (CL).

A very wet area was noted in the west abutment/embankment groin downstream from about station 3+75. Seepage in this area was outcropping at about elevation 750 which is some 8 feet above the elevation of the principal spillway outlet conduit. Seepage was also noted in the right abutment groin at about the same elevation as on the right abutment. Seepage in both abutments seemed to be ponded in the heavy vegetative cover and appeared to be clear.

- c. Project Geology. See Appendix C for geology report.

- d. Appurtenant Structures.

- (1) Principal Spillway. The concrete in the spillway appears to be in good condition. The lake level was 0.2 foot below the spillway crest elevation at the time of the inspection.
- (2) Emergency Spillway. The emergency spillway is well vegetated with brome grass and vetch. It looked very good with no evidence of erosion in the bottom or side slopes.

Some gully headcutting was noted at the outlet end of the diversion along the west (left) side of the spillway.

- d. Reservoir Area. No wave wash, excessive erosion or slides were observed along the shoreline of the reservoir.
- e. Downstream Channel. The channel downstream from the emergency spillway is overgrown with trees and brush. However, spillway discharges from this dam are collected in the reservoir just downstream from this structure.

3.2 EVALUATION

None of the conditions observed indicate a need for immediate remedial action. Additional studies would be required to evaluate the affects of seepage on the stability of the structure. Erosion at the outlet of the west spillway diversion could encroach on the emergency spillway if left uncontrolled. Trees in the channel downstream from the emergency spillway should not affect the operation of the spillway. The discharges from this dam are impounded by a downstream reservoir in which high water levels will almost impinge upon the downstream toe of this structure.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool level is controlled by rainfall, runoff, evaporation and capacity of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM

The dam is reasonably well maintained. Action should be taken to correct the minor deficiencies noted in Sections 3 and 7.2.

4.3 MAINTENANCE OF OPERATING FACILITIES

There are no operating facilities at this dam.

4.4 DESCRIPTION OF WARNING SYSTEM IN EFFECT

The inspection team is not aware of any existing warning system for this dam.

4.5 EVALUATION

The dam and appurtenances appear to be well maintained with the exception of some laxity in controlling erosion near the outlet of the emergency spillway.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

- a. Design Data. Detailed plans for the structure were furnished by the SCS. Pertinent hydraulic and hydrologic data which were taken from as-built plans furnished by the SCS are tabulated in Sections 1, 1.3 and in Appendix D as hydrologic computations. The supporting computations are attached.
- b. Experience Data. The drainage area, reservoir water surface areas, and elevation-storage data were taken from the SCS as-built plans. The hydraulic computations for the spillway discharge ratings were based on data taken from the as-built plans. The hydraulic computations for the dam overtopping rating were based on data collected during the field inspection in order to reflect settled conditions.
- c. Visual Observations.
 - (1) Principal and emergency spillways are in good condition.
 - (2) The emergency spillway does not appear to have ever been used.
 - (3) The emergency spillway and exit channel are in the left hillside at the end of the dam. Spillway use should not endanger the integrity of the dam.
- d. Overtopping Potential. The spillways are too small to pass 50% of the probable maximum flood without overtopping. The spillways will pass 40% of the PMF without overtopping. The 100-year (1 percent) peak outflow discharge is approximately 37% of spillway capacity. The results of the routing through the reservoir are tabulated in regards to the following conditions.

<u>Frequency</u>	<u>Peak Inflow Discharge c.f.s.</u>	<u>Peak Outflow Discharge c.f.s.</u>	<u>Maximum Pool Elevation</u>	<u>Freeboard Top of Dam Min. Elev. 763.4</u>	<u>Time Dam Overtopping Hrs.</u>
100-Year	690	360	762.0	+1.4	-
1/2 PMF	1630	1290	764.0	-0.6	1.0
PMF	3310	3200	765.3	-1.9	3.8
0.40 PMF	1290	970	763.4	0	-

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a high hazard rating and a small size. Therefore, the PMF is the test for the adequacy of the dam and its spillways.

The St. Louis District, Corps of Engineers, in a letter dated 11 August, 1978 has estimated the damage zone as extending one mile downstream from the dam. Within the damage zone are four to five houses, one railroad crossing and one State Highway crossing.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observations. Minor maintenance features that could affect the long time safety of the dam are discussed in Section 3.2. Additional studies are required to evaluate the affects of seepage in the downstream abutment groins upon structural stability of the dam.

Hydraulic/Hydrologic analyses presented in Section 5 indicate that the dam will be overtopped by the probable maximum flood. Under those conditions, water would flow over the top of the dam to a depth of 1.9 feet \pm for about 3.8 hours.

- b. Design and Construction Data. The engineering data, analyses, and plans supplied by the SCS conform with accepted practice and are considered adequate to assess the structural stability of the dam.

There is no reason to question the adequacy of construction supervision and quality control.

- c. Operating Records. There are no appurtenant structures that require operational functions.
- d. Post Construction Changes. The inspection party is not aware of any post construction changes.
- e. Seismic Stability. This dam is located in the Zone 1 seismic probability classification area. An earthquake of this magnitude is not expected to cause structural failure of this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

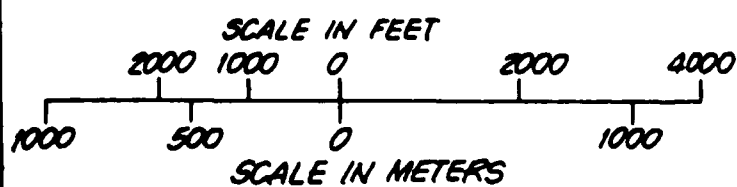
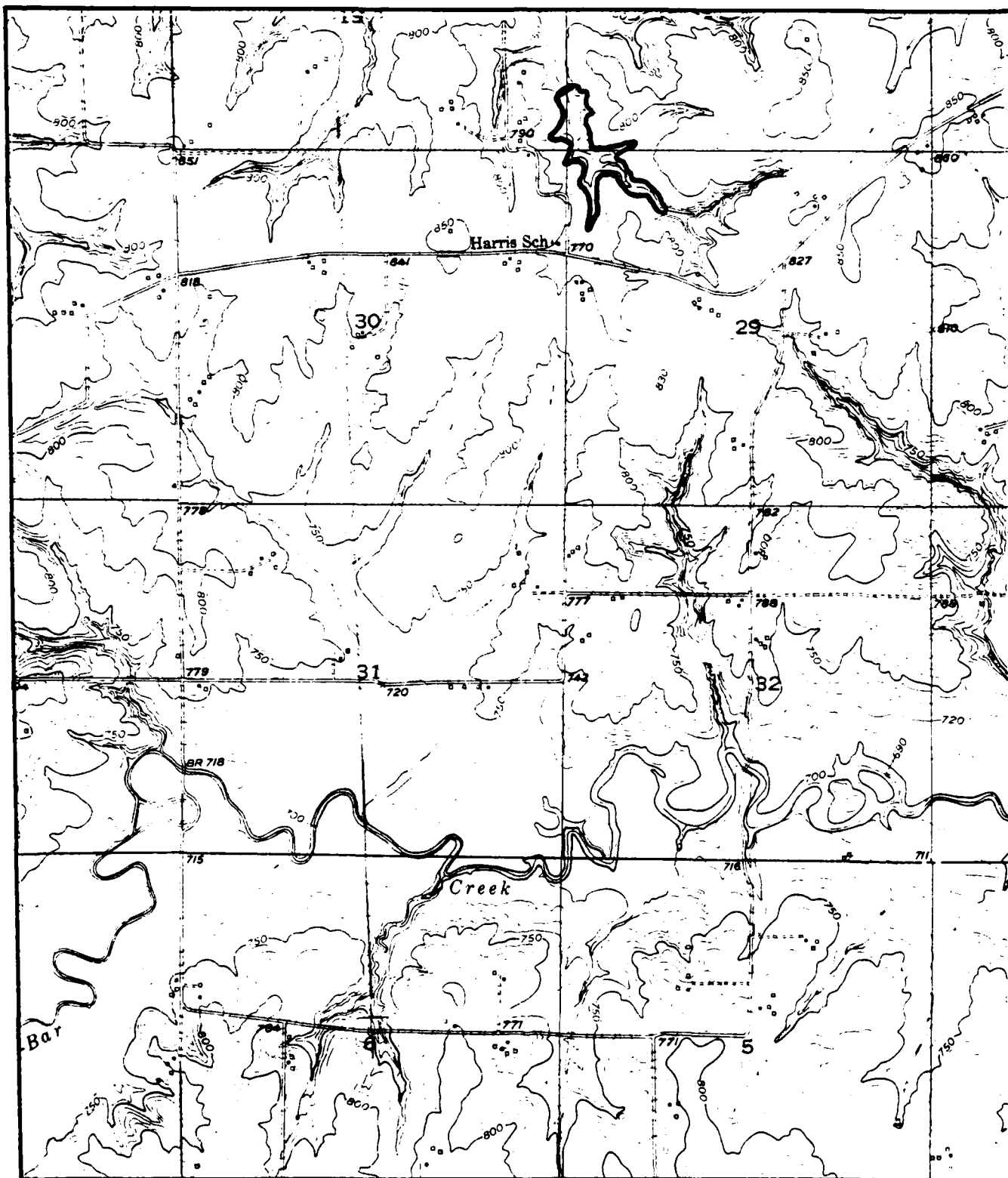
7.1 DAM ASSESSMENT

- a. Safety. The probable maximum flood (PMF) will overtop the dam, however, the spillways are adequate to pass the flood resulting from 40% of the PMF without overtopping. Seepage observed at the downstream toe could affect the long-time stability of the structure. Rodent holes on the upstream slope could lead to potential of failure if left uncontrolled.
- b. Adequacy of Information. The information presented in this report is considered adequate to assess the safety of the structure. Seepage analysis were not found, which is a deficiency that should be corrected in the future.
- c. Urgency. There does not appear to be an immediate urgency to accomplish the remedial measures discussed in Paragraph 7.2.
- d. Necessity for Phase II. Phase II investigations are not considered necessary for this dam.
- e. Seismic Stability. An earthquake of the magnitude to be expected in this area should not be hazardous to this structure.

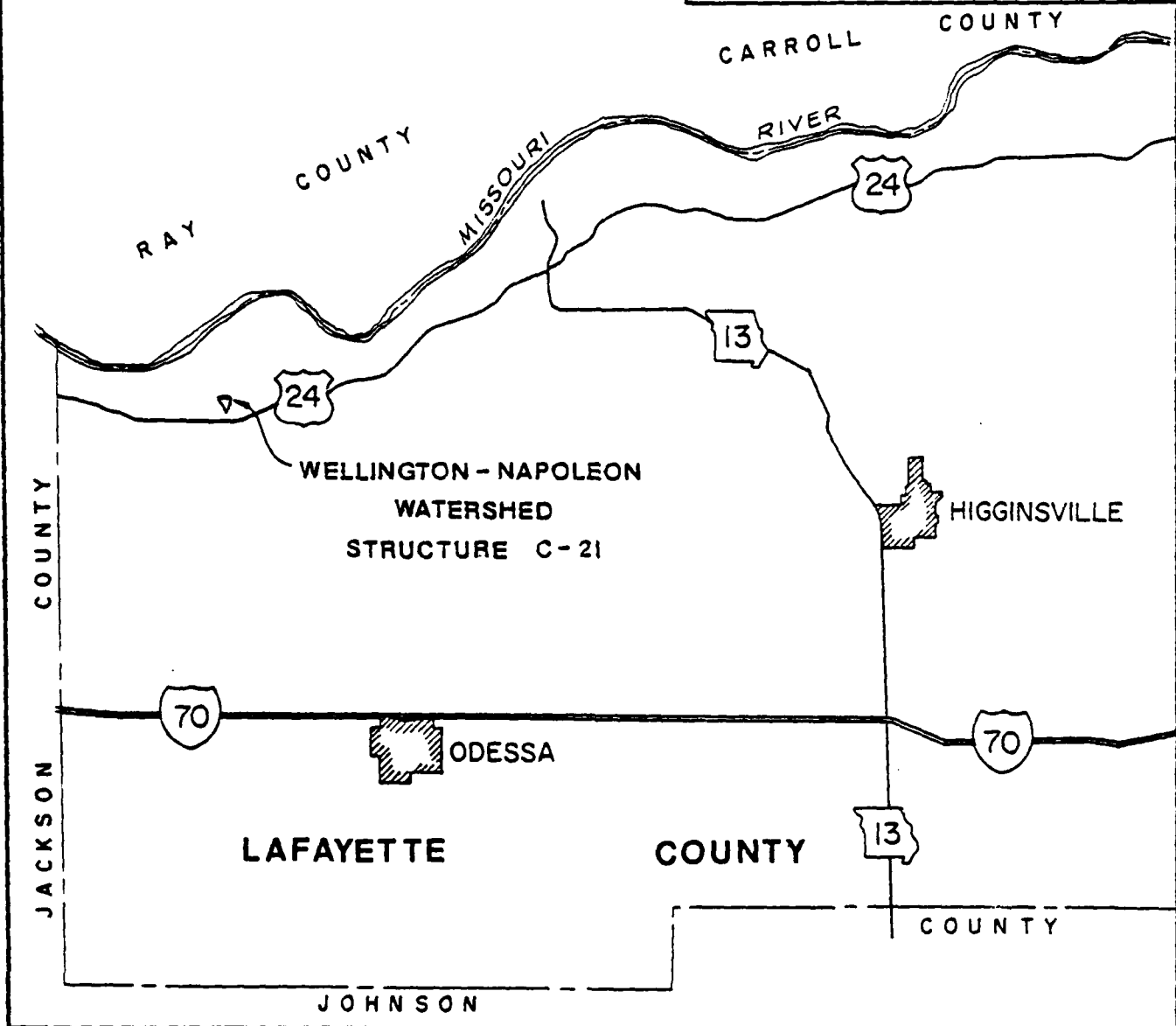
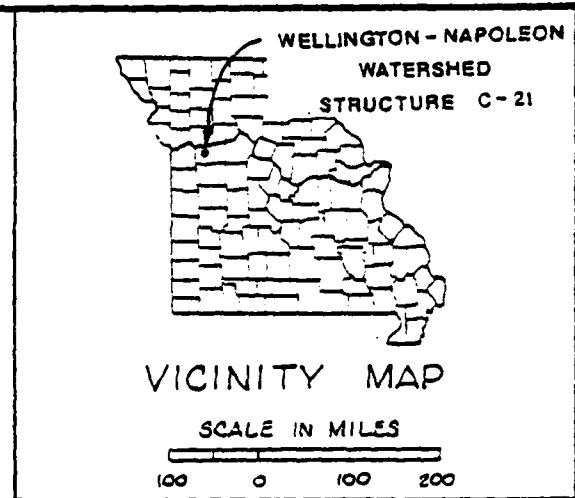
7.2 REMEDIAL MEASURES

- a. Alternatives.
 - (1) The size of the present emergency spillway should be enlarged or a supplemental spillway constructed on the right abutment to pass the probable maximum flood without overtopping the dam.
 - (2) Additional analyses should be made to assess the affects of seepage on the stability of the structure.
 - (3) The owner should engage the services of an engineer experienced in the design of dams to design an adequate spillway system and to evaluate the affects of seepage on the structural stability of the dam.
- b. O & M Maintenance and Procedures.
 - (1) A program of regular inspection and maintenance should be initiated. The program should include measures to repair and control rodent holes and to control future tree growth (none observed at this time) on the embankment and to evaluate the progress and possible future affects of gully erosion near the outlet of the present emergency spillway. The grass on the embankment should be routinely mowed to enable early detection of rodent holes.

APPENDIX A
MAPS



WELLINGTON - NAPOLEON
WATERSHED
STRUCTURE C-21
VICINITY TOPOGRAPHY
PLATE I



LOCATION MAP
PLATE 2

APPENDIX B
PHOTOGRAPHS



PHOTO NO. 2
LOOKING DOWNSTREAM
IN EMERGENCY SPILLWAY



PHOTO NO. 3
LOOKING UPSTREAM IN
EMERGENCY SPILLWAY



PHOTO NO. 4
DAM AND LAKE TAKEN
FROM LEFT SIDE

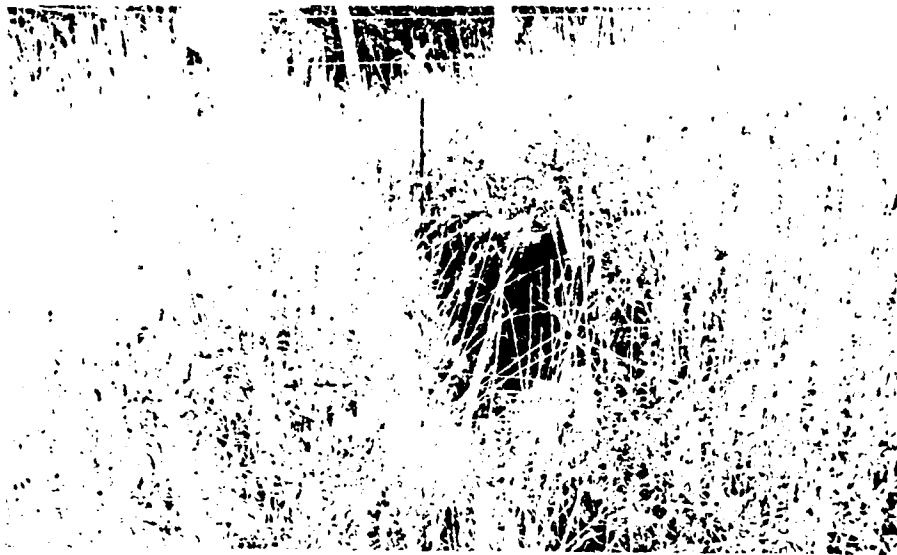


PHOTO NO. 5
GULLY EROSION
IN LEFT SIDE
EMERGENCY SPILLWAY



PHOTO NO. 6
UPSTREAM SLOPE
FROM APPROXIMATE
CENTER LINE



PHOTO NO. 7
DOWNSTREAM SLOPE
FROM APPROXIMATE
CENTER LINE



PHOTO NO. 8
CREST OF DAM
TAKEN FROM
RIGHT ABUTMENT



PHOTO NO. 9
RODENT HOLE
IN UPSTREAM SLOPE.
APPROX. STATION 3+00

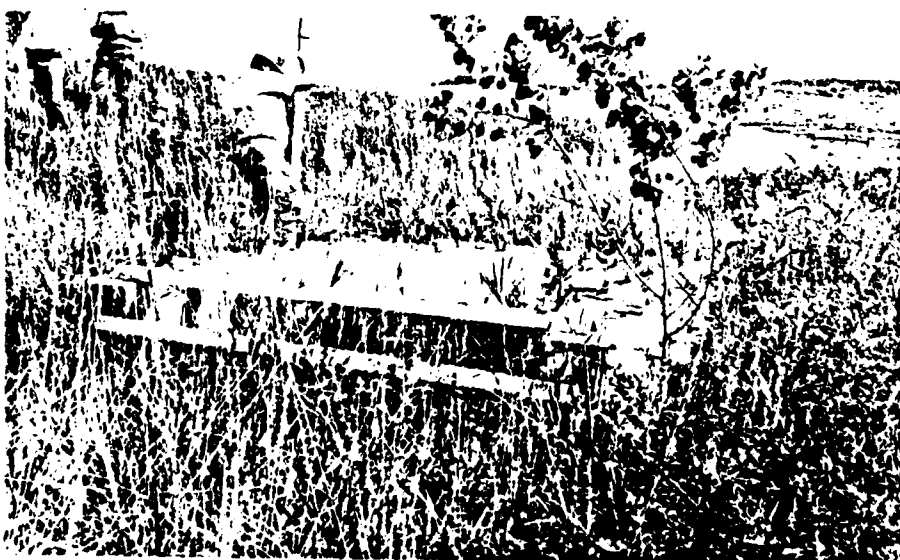


PHOTO NO. 10
PRINCIPAL SPILLWAY
RISER

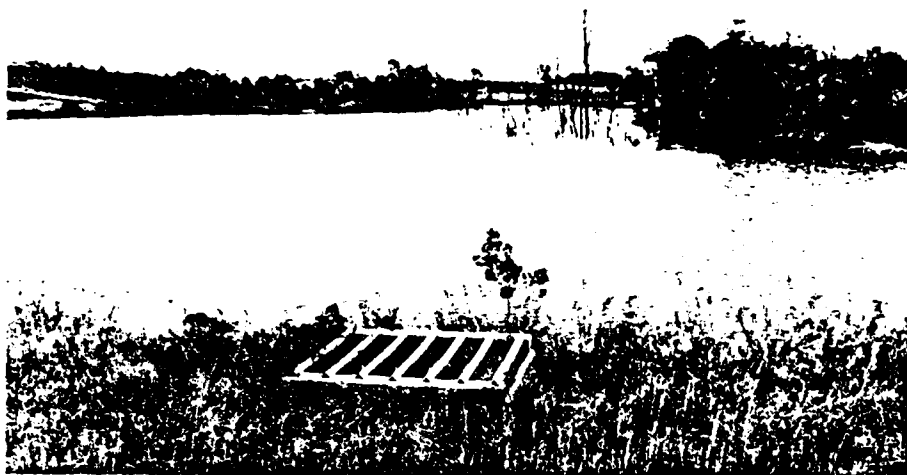


PHOTO NO. 11
LOOKING UPSTREAM
FROM CREST



PHOTO NO. 12
LOOKING DOWNSTREAM
FROM CREST



PHOTO NO. 13
OUTLET END OF
PRINCIPAL SPILLWAY



PHOTO NO. 14
UPPER END OF SEEPAGE
SPOT AT STATION 0+50±

APPENDIX C
PLANS AND REPORTS

Note: Reproductions of plans and reports included in Appendix C are the best possible from copy furnished by Soil Conservation Service. Unreadable portions on the reproduced sheets are also unreadable on sheets from which the copies were made.

BM C-21 Elev. 760.80
 Top of brass cap on concrete monument located in
 fence corner approx. 18' south of westgate on emergency
 highway and of dam. 58.4 Sec. 14, T.50N., R.20W.

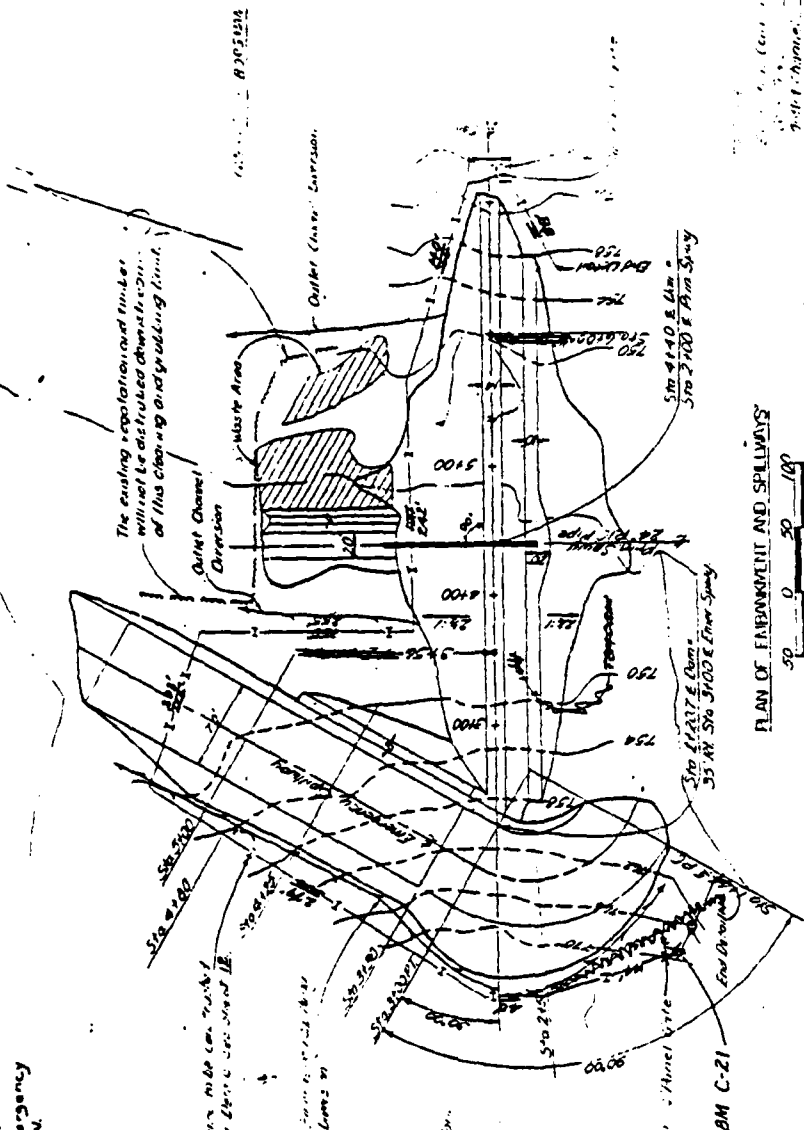
Top of concrete dam 770.00
 Top of concrete dam 770.00
 Top of concrete dam 770.00

Top of concrete dam 770.00
 Top of concrete dam 770.00
 Top of concrete dam 770.00

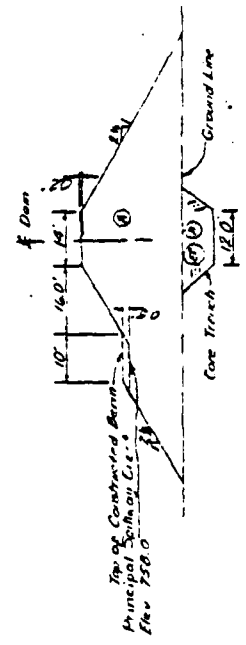
Top of concrete dam 770.00
 Top of concrete dam 770.00
 Top of concrete dam 770.00

Top of concrete dam 770.00
 Top of concrete dam 770.00
 Top of concrete dam 770.00

90.00
05.00
13.50
05.00
67.24



PLAN OF EMBANKMENT AND SPILLWAYS

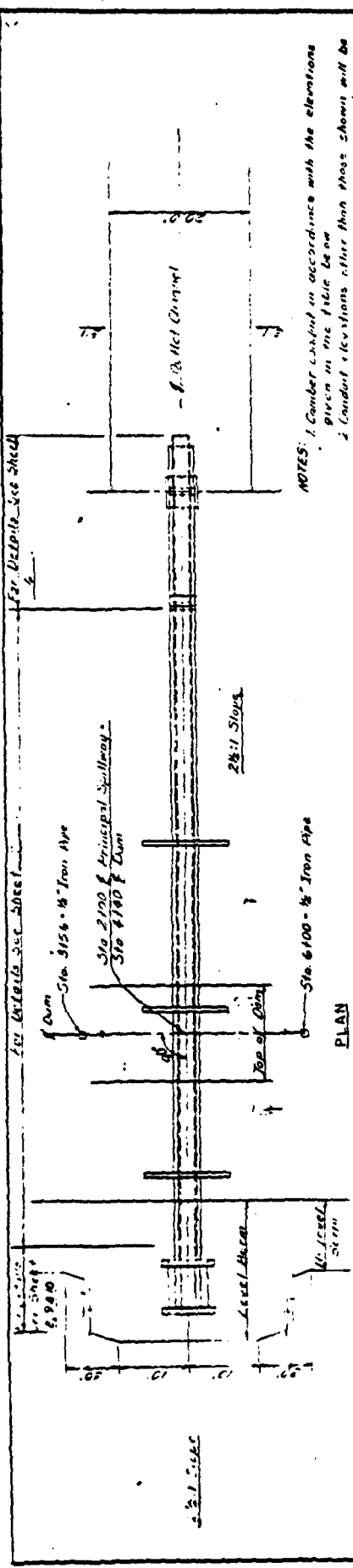


TYPICAL SECTION OF EMBANKMENT

AS BUILT 11-25-61

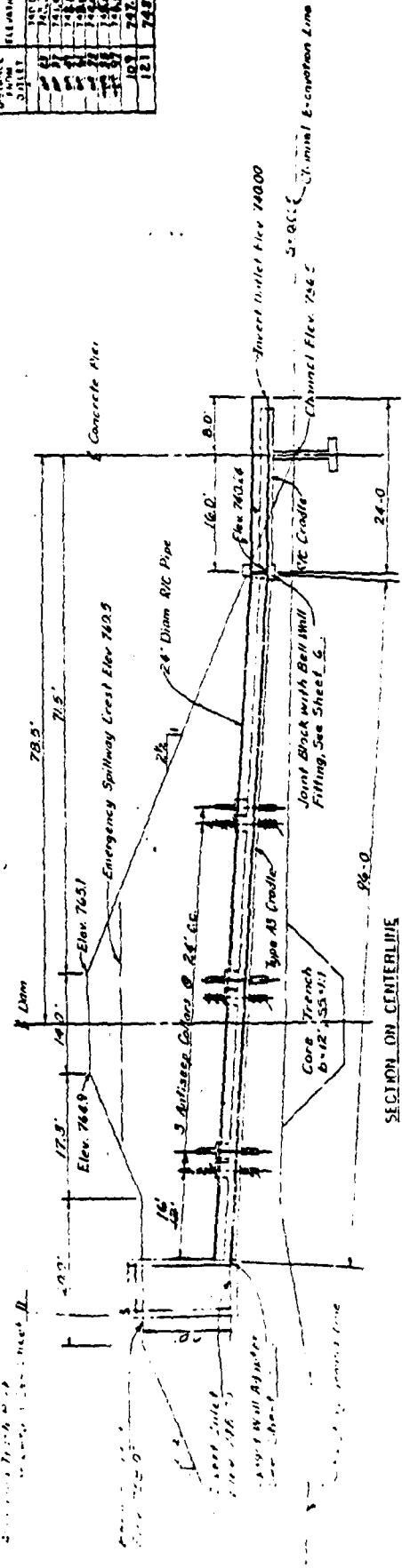
STRUCTURE C-21	
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	
Project No.	56-2540
Drawn by	DL
Check by	DL
Date	11-25-61

1216
 57
 1348
 1986



NOTES: 1. Conduit laid in accordance with the elevations given in the table below.
 2. Conduit elevations other than those shown will be furnished by the Engineer, when required.
 3. Antiseep valves shall not be placed closer than two (2) feet to a pipe joint.

PIPE CENTER	STATION	ELEVATION
121	6100	742.00
122	6110	742.00
123	6120	742.00
124	6130	742.00
125	6140	742.00
126	6150	742.00
127	6160	742.00
128	6170	742.00
129	6180	742.00
130	6190	742.00
131	6200	742.00



SECTION ON CENTERLINE



AS BUILT 11-25-61

STRUCTURE C-21

GENERAL LAYOUT

R.C. DRAIN PIPE FOR 24" DIAM. PIPE

WELDED WIRE MESH REINFORCED PL366

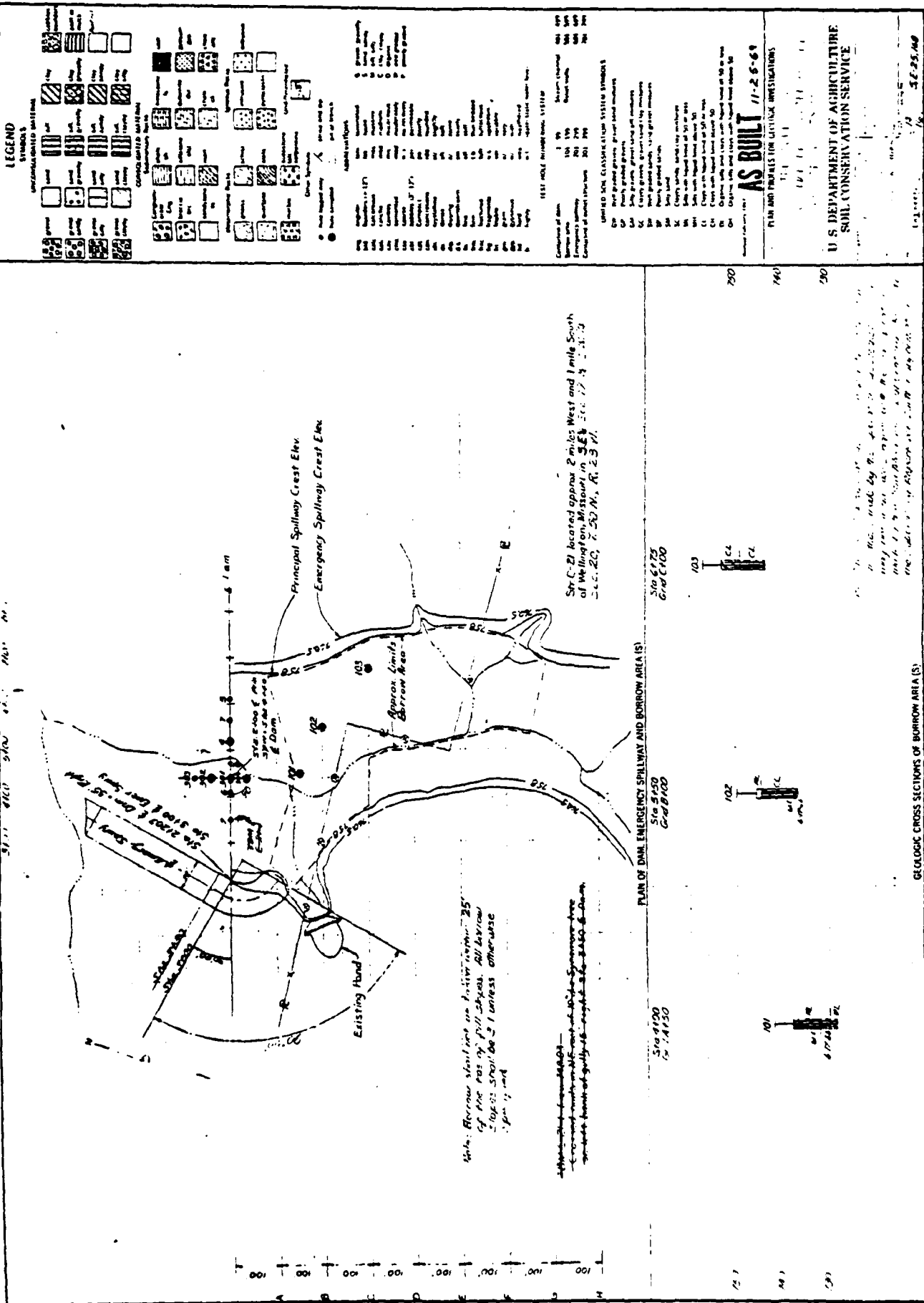
LAFAYETTE COUNTY, MISSOURI

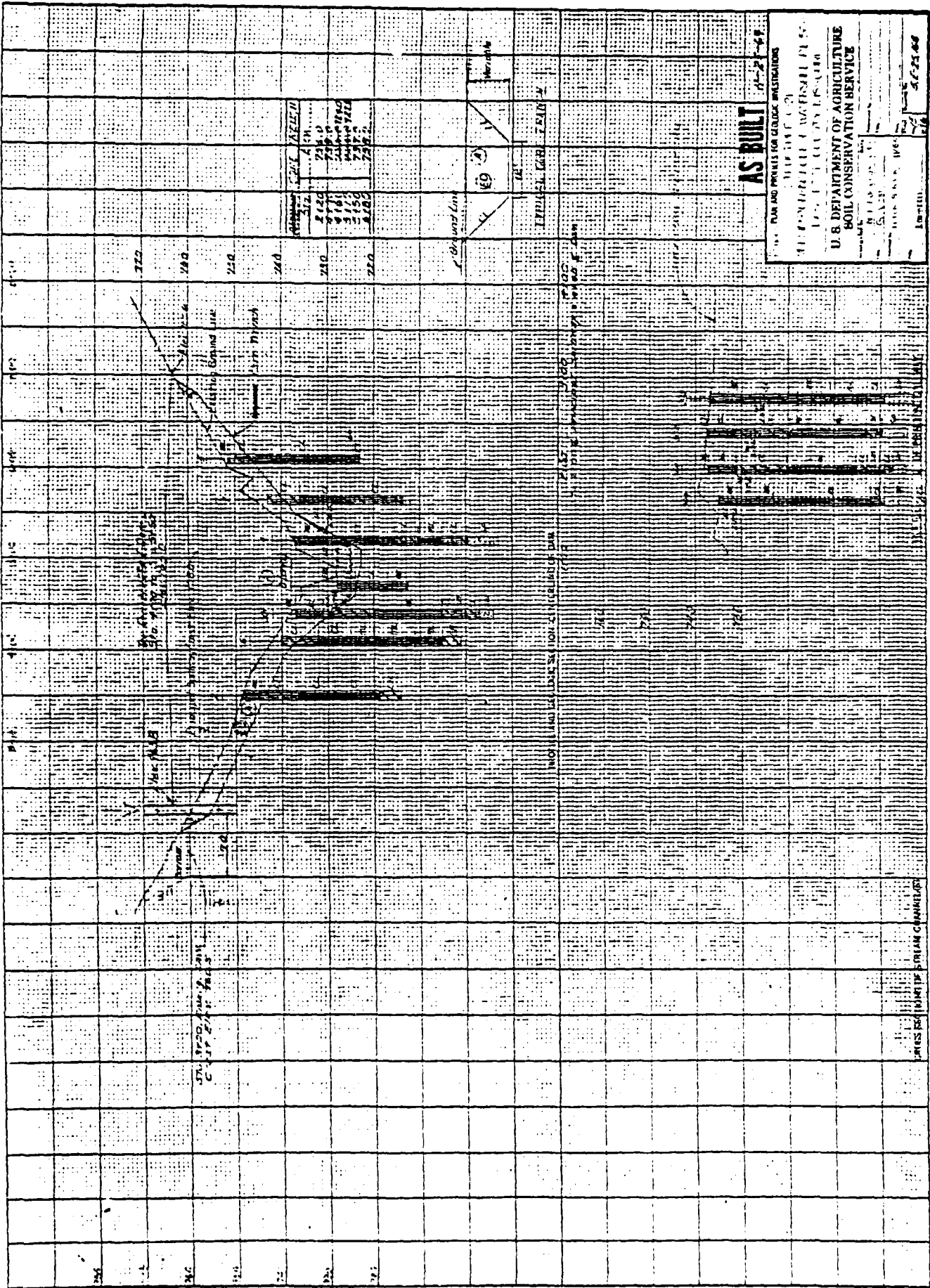
U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

QUANTITIES

Concrete - Class 4000, Plain	11.6 Cu Yds
Concrete - Class 4000, Reinforced	21.2 Cu Yds
Steel Bar Reinforcement	2275 Pounds
Pipe Conduit - Reinforced Concrete (Pressure) 24" Diam., Steel Ring Type Joint and Rubber Gasket	120 Lin Ft
Aluminum Trash Rack	Lump Sum





AS BUILT

PLAN AND PROFILE FOR GRADE INVESTIGATIONS

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PROJECT NO. 10-27-48

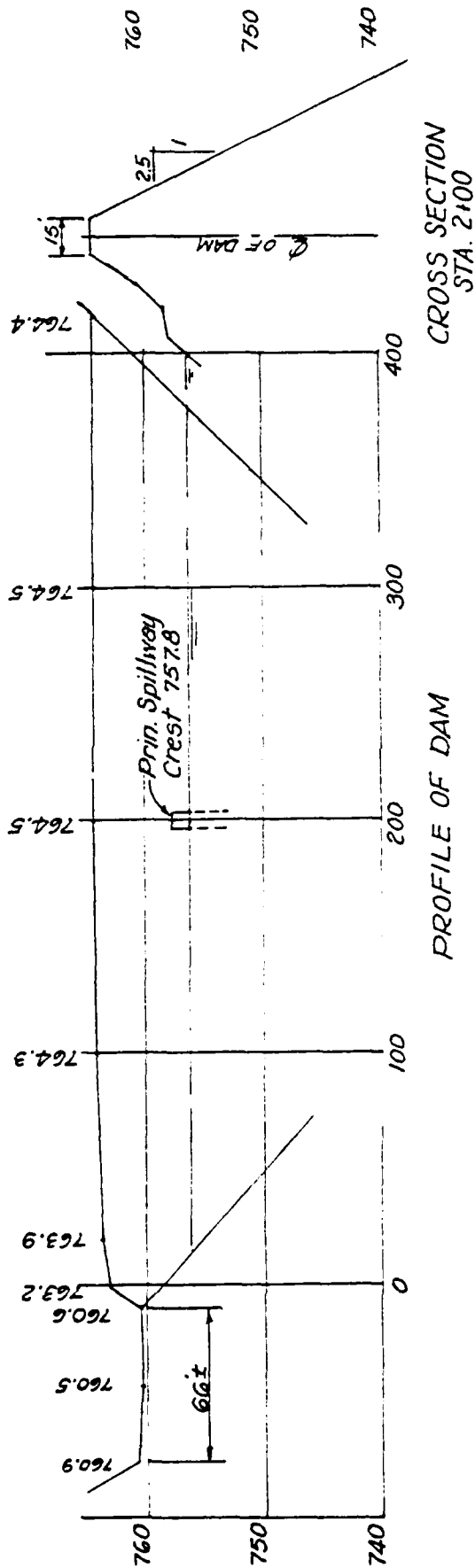
DATE 10-27-48

BY J. H. HARRIS

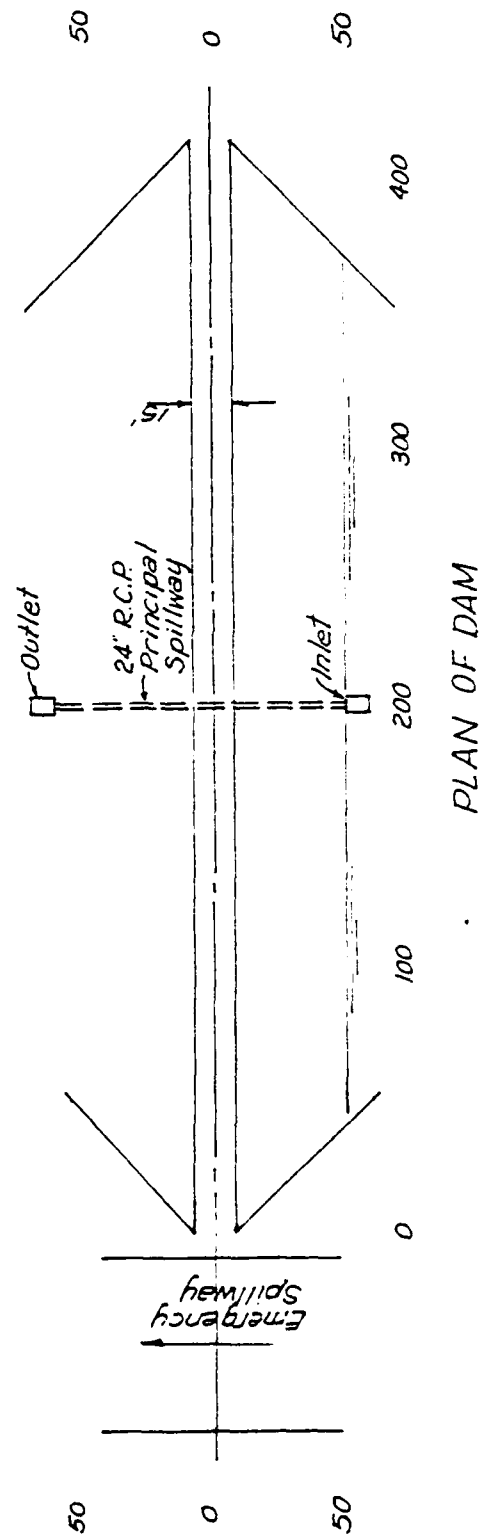
CHECKED BY J. H. HARRIS

APPROVED BY J. H. HARRIS

LOCATION 10-27-48



WELLINGTON - NAPOLEON
WATERSHED STRUCTURE C-21
NATIONAL DAM SAFETY PROGRAM
PHASE I



UNITED STATES GOVERNMENT

Memorandum

TO : James M. Dale, State Conservation Engineer,
SCS, Columbia, Missouri 65201

DATE: October 28, 1966

FROM : Roland B. Phillips, Acting Head, Soil Mechanics Laboratory,
SCS, Lincoln, Nebraska 68508

SUBJECT: ENG 22-5, Missouri WP-08, Wellington-Napoleon, Site No. C-21 (Lafayette Co.)

ATTACHMENTS

1. Form SCS-354, Soil Mechanics Laboratory Data, 4 sheets.
2. Form SCS-127, Soil Permeability, 2 sheet.
Form SCS-128, Consolidation Test, 5 sheets.
Form SCS-128A, Log Time Consolidation, 3 sheets.
3. Form SCS-355A, Triaxial Shear Test, 1 sheet.
4. Form SCS-352, Compaction and Penetration Resistance, 4 sheets.
5. Form SCS-357, Summary - Slope Stability Analysis, 2 sheets.
6. Investigational Plans and Profiles.

REVIEW AND INTERPRETATION OF DATA

FOUNDATION MATERIALS

- A. Classification: The site consists of Loess in the abutments that classes as CL and alluvium in the valley bottom that classes as CL and ML with some deep sands. There is a CH at about a 30 ft depth.

An area of organic silt as thick as 20 ft is noted from the channel toward the left abutment.

- B. Dry Unit Weight (Blow Count): Four undisturbed core samples were submitted. Three were from the surface ML and CL alluvium and ranged in dry unit weight from 1.37 g/cc to 1.56 g/cc with blow count from 2 to 5 blows per foot. One was from the deeper organic silts and ranged from 1.07 g/cc to 1.08 g/cc but at 14 blows per foot.

All the blow counts ranged from 2 to 11 blows per foot in the alluvium, from 9 to 20 blows per foot in the organic silt and from 18 to 20 blows below those silts.

- C. Consolidation: Consolidation tests were made on the CL sample 67W326 from a 10 ft to 11 ft depth and on the ML (organic silt) sample 67W328 from a 22 ft to 23 ft depth.

The CL was at an initial density of 1.47 g/cc and a consolidation potential of about .025 ft/ft is indicated under the fill at floodplain level.

2 -- James M. Dale -- 10/28/66

Roland B. Phillips

Subj: ENG 22-5, Missouri WP-08, Wellington-Napoleon, Site No. C-21

The ML was at a density of 1.18 g/cc and a consolidation potential of about .020 ft/ft is indicated. The potential would be very high under a high fill. The sample may have been slightly disturbed in sampling so its potential is actually assumed as .015 ft/ft. This indicates a total foundation consolidation of 0.65 ft at Station 4+50. A maximum horizontal strain of .007 ft/ft is computed with $b = 200$ ft, $h = 36$ ft, and $d = 32$ ft for the 2 1/2:1 slopes and 10 ft berm as proposed.

- D. Permeability: Rates were determined for the CL and the organic ML during consolidation. They are $K = .024$ ft/day for CL and $K = .0035$ ft/day for the ML. These rates were obtained by extrapolating values found after consolidation to the in-place density of the sampled materials.

Rates for the sands will be higher. The SP may correlate to the SP-SM from sites No. B-21 and C-22 for which rates of $K = 10.0$ ft/day were estimated.

- E. Shear Strength: A consolidated, undrained triaxial shear test on the CL sample, 67W326 (301-9), yielded shear parameters of $\phi = 18^\circ$, $c = 750$ psf at a test density of 1.49 g/cc. This is considered to be a limiting foundation strength.

EMBANKMENT MATERIALS

- A. Classification: Borrow samples submitted all class as CL though surface materials are more silty.
- B. Compacted Dry Densities: Standard Proctor compaction tests, (ASTM D-698-A) yielded maximum dry densities from 103.0 pcf to 105.0 pcf.
- C. Permeability: No tests were made. Based on classification, compacted materials will have low permeability rates.
- D. Shear Strength: Shear strength for the embankment CL materials is correlated to like materials from sites B-21 and C-23 with $\phi = 10^\circ$, $c = 1150$ psf for the most plastic and $\phi = 17^\circ$, $c = 925$ psf for the less plastic material.
- E. Consolidation: No tests were made. Based on the classification of materials residual settlement within the fill should not exceed 2 1/2% of the fill height.

3 -- James M. Dale -- 10/28/66

Roland B. Phillips

Subj: ENG 22-5, Missouri WP-08, Wellington-Napoleon, Site No. C-21

SLOPE STABILITY ANALYSIS

Slopes stability was checked by a circular failure method both for a 35.3 ft embankment only and for 23 ft of foundation. The most critical case was found for failure through the foundation but a minimum upstream safety factor of 1.67 was computed for the 2 1/2:1 slope under full drawdown effects. This is a very rigorous analysis and the results indicate the 2 1/2:1 slopes are satisfactory.

SETTLEMENT STRAINS

Settlement strains should not cause high differentials if steep banks are sloped to 3:1 or flatter and no soft material is left under the fill.

CONCLUSIONS AND RECOMMENDATIONS

- A. Cutoff: A shallow cutoff trench (3 ft - 6 ft) is recommended to intercept the surface ML and any surface disturbances such as root holes and animal burrows.

Backfill with CL placed at 95% of standard.

- N: 2-1-1
B. Principal Spillway: The pipe cradle can be set on relatively firm silty CL without over excavation. The trench should have a wide bottom and 3:1 side slopes or flatter.

Backfill at high density near the pipe but feather out away from it to fit the 95% of standard used in the fill.

Base pipe joints on a maximum horizontal strain of .007 ft/ft.

Use $\phi = 25^\circ$ for conduit loading computations.

- C. Drainage: Drainage is not needed for slope stability. It is not recommended.

- D. Embankment Design: Provide a homogeneous fill of the available CL borrow placed at 95% of standard density. Control moisture at two percentage points below optimum to three above.

Use 2 1/2:1 slopes with the proposed 10 ft upstream berm at about elevation 7580.

Provide overfill of 1.4 ft from $\frac{1}{2}$ Station 4+00 to 5+50 to compensate for residual settlement of 0.65 ft in the foundation and 0.75 ft within the fill.

cc:

James M. Dale (2) E. S. Alling
Gerald McElhiney D. S. McVicker

MISSOURI DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

455 "B"
TERRILL 12A-50, 2-21-66, DETAILMENT

7-19-66

7-19-66

LABORATORY SAMPLE NUMBER	FIELD NUMBER	MISSOURI LOCATION AND DESCRIPTION	DEPTH FOOT	FIELD CLASS INITIALS	GRAIN SIZE DISTRIBUTION EXPRESSED AS PERCENT FINER BY DRY WEIGHT												ATTENDING LIMITS	UNITED CLASS INITIALS	SOURCE SALTS	DIS SECTION	RELATIVE DENSITY RELATIONSHIPS			ANALYTICAL SAMPLE DATA																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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5128 8.1F
3.2Vd

5128 8.1F
3.2Vd

5128 8.1F
3.2Vd

LABORATORY SAMPLE NUMBER		FIELD NUMBER	MISSOURI LOCATION AND DESCRIPTION	SITE NO. C-21	DEPTH	FIELD CLASS NOTATION	GRAIN SIZE DISTRIBUTION EXPRESSED AS PERCENT FINER BY DRY WEIGHT															ATTENBERG LIMITS	UNITED CLASS. NOTATION	SOURCE SALTIN	DIS- PER- SION %	MOISTURE RELATIONSHIPS STANDARD OR MODIFIED	UNCLASSIFIED SAMPLE DATA	G ₁																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
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							0.002 mm.	0.005 mm.	0.0075 mm.	0.015 mm.	0.03 mm.	0.06 mm.	0.075 mm.	0.15 mm.	0.25 mm.	0.425 mm.	0.6 mm.	0.85 mm.	1.18 mm.	1.75 mm.	2.5 mm.								3.75 mm.	4.75 mm.	6.0 mm.	7.5 mm.	9.5 mm.	12.5 mm.	15.0 mm.	19.0 mm.	25.0 mm.	30.0 mm.	37.5 mm.	47.5 mm.	60.0 mm.	75.0 mm.	95.0 mm.	118.0 mm.	150.0 mm.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
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[illegible]

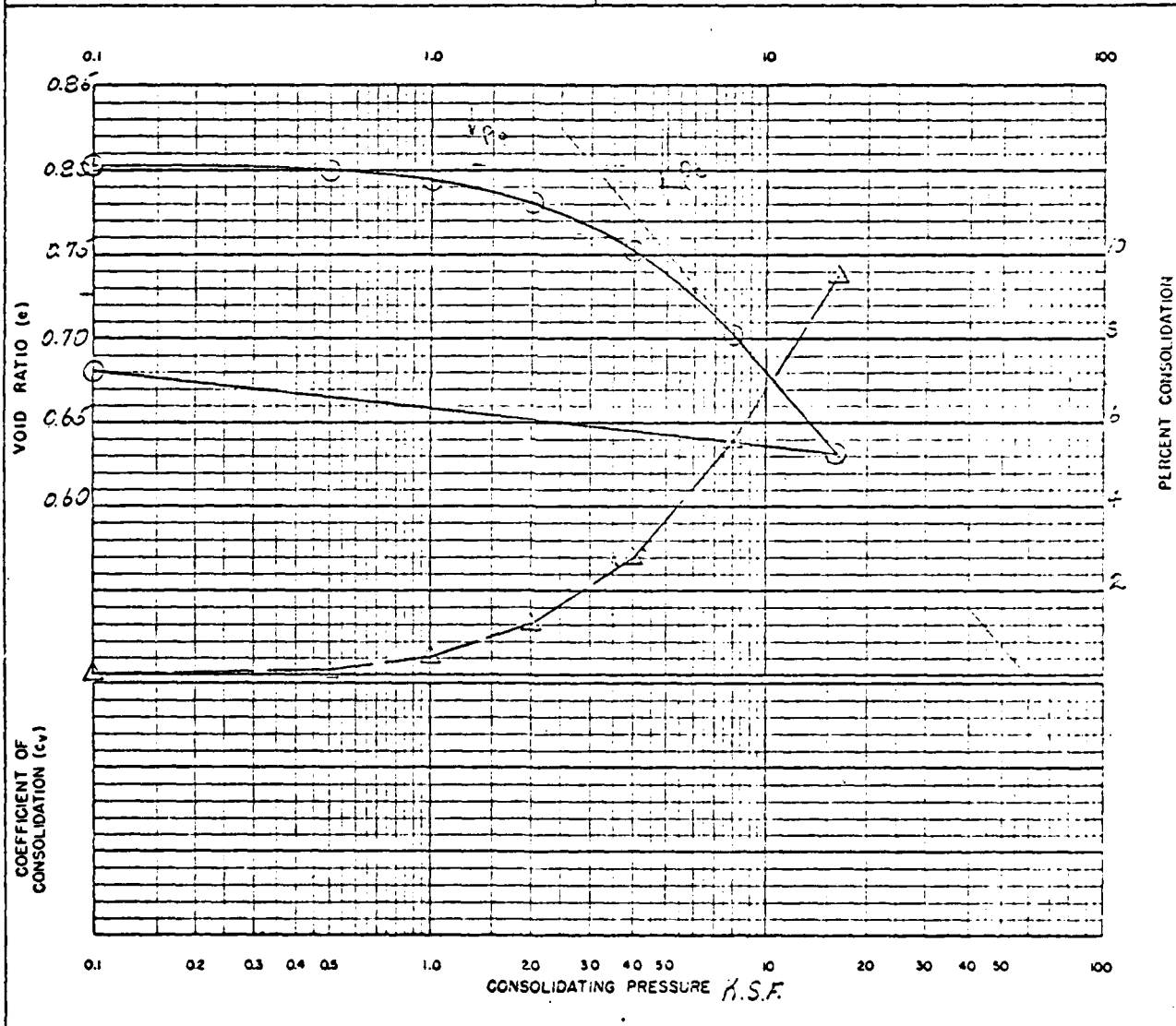
MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	CONSOLIDATION TEST
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PROJECT and STATE <u>WELLSFORD-HOLLEMAN #21 MISSOURI</u>	SAMPLE LOCATION <u>CELL 4-40</u>
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FIELD SAMPLE NO. <u>201-3</u>	DEPTH <u>10-11.5'</u>	GEOLOGIC ORIGIN
----------------------------------	--------------------------	-----------------

TYPE OF SAMPLE <u>UNDISTURBED</u>	TESTED AT <u>LINCOLN</u>	APPROVED BY	DATE
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CLASSIFICATION <u>CL</u> G_s <u>2.65</u> LL <u>37</u> PI <u>12</u> INITIAL DENSITY γ_d <u>1.47</u> INITIAL VOID RATIO, e_0 <u>0.828</u> COMPRESSION INDEX, C_c <u>1.23</u>	TEST SPECIFICATIONS: <u>Saturated at Start.</u>
---	--



REMARKS Use $C_v = 0.0010$ in²/sec.

MATERIALS TESTING REPORT		U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE		LOG TIME CONSOLIDATION	
PROJECT and STATE				SAMPLE LOCATION	
FIELD SAMPLE NO.		DEPTH		GEOLOGIC ORIGIN	
TYPE OF SAMPLE		TESTED AT		APPROVED BY	DATE

INITIAL THICKNESS OF TEST SPECIMEN in.

INITIAL DIAL READING in.

Handwritten notes on graph:

- $q = 1000 \text{ psf}$
- $q = 2000 \text{ psf}$
- $q = 4000 \text{ psf}$
- $q = 7025 \text{ psf}$
- $C_v = 1.5 \times 10^{-9} \text{ in}^2/\text{sec}$
- $U = 45\%$
- $U = 91\%$
- $U = 100\%$

TIME (sec)

REMARKS

MATERIALS TESTING REPORT

U. S. DEPARTMENT of AGRICULTURE
SOIL CONSERVATION SERVICE

LOG TIME CONSOLIDATION

PROJECT and STATE

SAMPLE LOCATION	
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100	1000

FIELD SAMPLE NO.

DEPTH

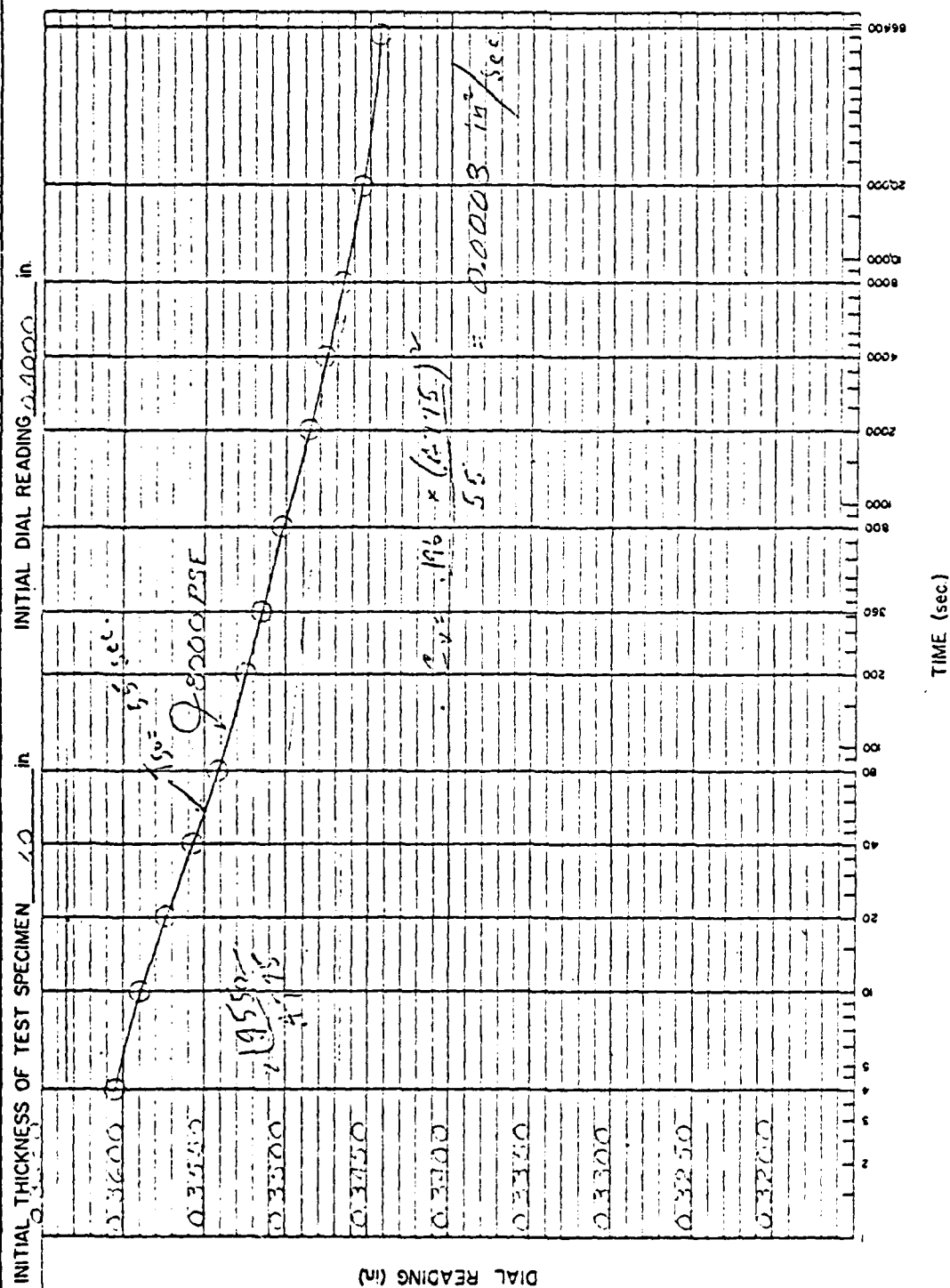
GEOLOGIC ORIGIN

TYPE OF SAMPLE

TESTED AT

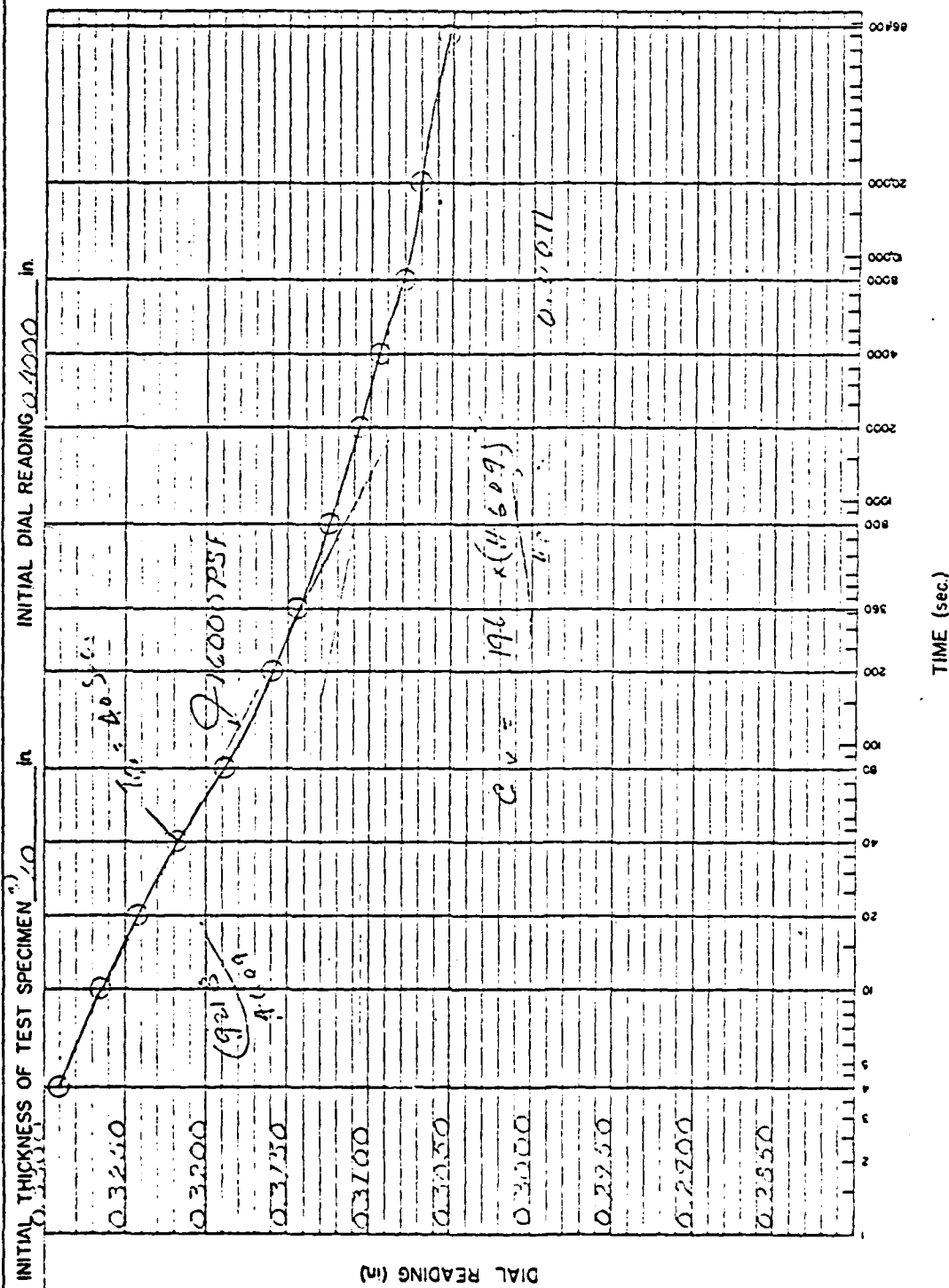
APPROVED BY

DATE



REMARKS

MATERIALS TESTING REPORT		U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE		LOG TIME CONSOLIDATION	
PROJECT and STATE WATERWAY-4130/504 NO 2-21 MISSOURI				SAMPLE LOCATION 3.511 4-40	
FIELD SAMPLE NO. 301-9	DEPTH 100-11.5	GEOLOGIC ORIGIN			
TYPE OF SAMPLE UNDISTURBED	TESTED AT LINCOLN	APPROVED BY		DATE	



REMARKS

MATERIALS TESTING REPORT		U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE		SOIL PERMEABILITY	
PROJECT and STATE <u>WELLINGTON-NAPOLEON 2-21 MISSOURI</u>				SAMPLE LOCATION <u>CL 111 4+40</u>	
FIELD SAMPLE NO. <u>301-9</u>	DEPTH <u>10'-11.5'</u>	GEOLOGIC ORIGIN			
TYPE OF SAMPLE <u>UNDISTURBED</u>	TESTED AT <u>LINCOLN</u>	APPROVED BY			DATE
CLASSIFICATION <u>CL</u>				SPECIFIC GRAVITY	
				<u>LL 37 PI 13</u>	
TEST NO	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	$G_s (-)^{\#4}$
INITIAL MOISTURE %					<u>2.65</u>
DRY DENSITY $\frac{g}{cc}$ $\frac{pcf}{pcf}$	<u>1.49</u>	<u>1.51</u>	<u>1.56</u>		$G_m (Bulk)(+)^{\#4}$
VOID RATIO	<u>0.7801</u>	<u>0.7525</u>	<u>0.7025</u>	TEST SPECIFICATIONS <u>Falling Head Perm Test on the Consolidation Sample</u>	
PERMEABILITY COEF cgs	<u>0.024</u>	<u>0.0042</u>	<u>0.0013</u>		
PERCOLATION COEF					
H_L DURING TEST					

VOID RATIO (e)

PERMEABILITY COEF (k) cm/sec

REMARKS

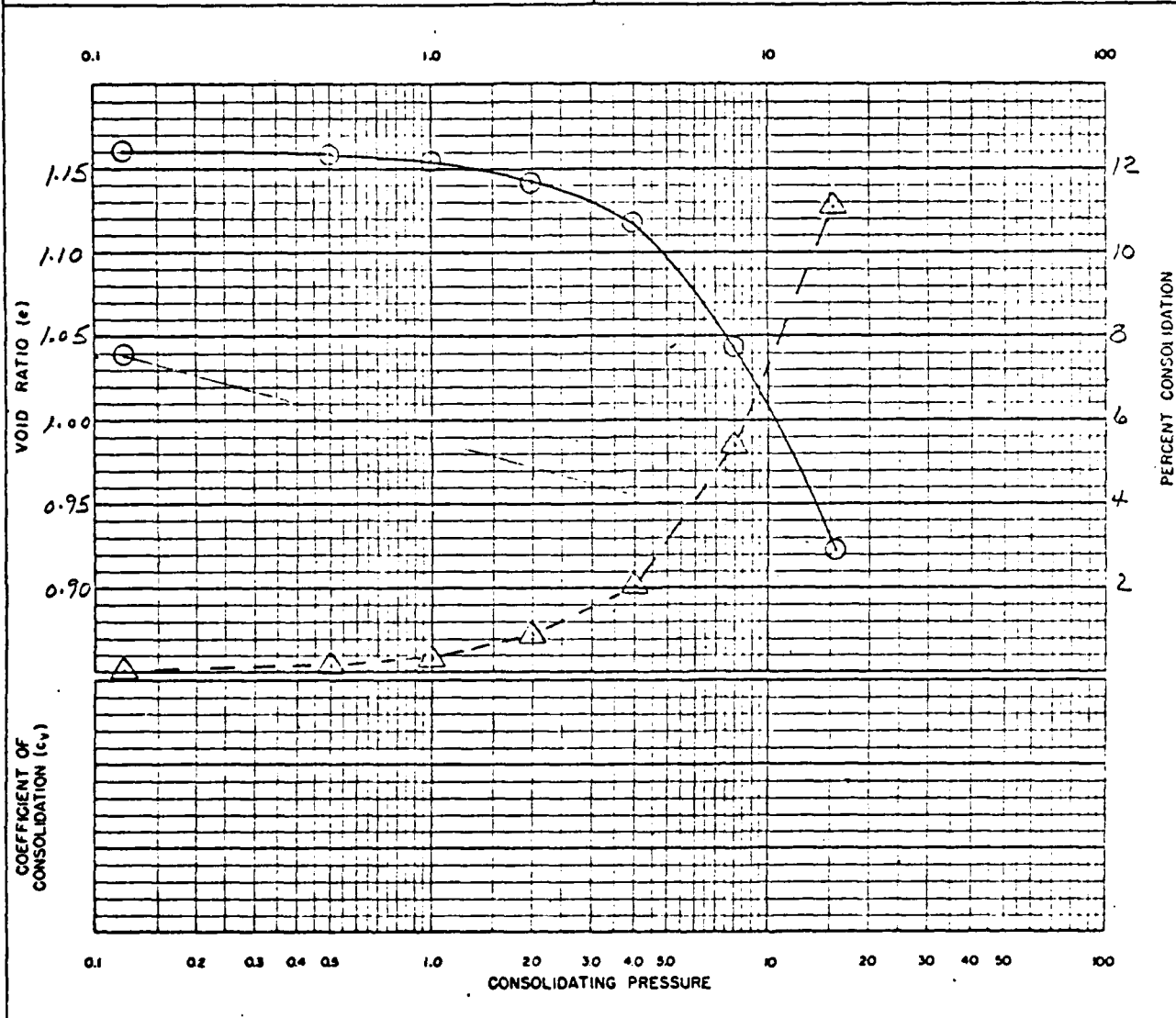
MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	CONSOLIDATION TEST
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PROJECT and STATE <u>WELLINGTON - MOBILE C-21 MISSOURI</u>	SAMPLE LOCATION <u>2 Fill Sta 4440</u>
---	---

FIELD SAMPLE NO.	DEPTH <u>22.0 - 23.5</u>	GEOLOGIC ORIGIN
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TYPE OF SAMPLE <u>undisturbed</u>	TESTED AT <u>SMS - Lincoln</u>	APPROVED BY	DATE
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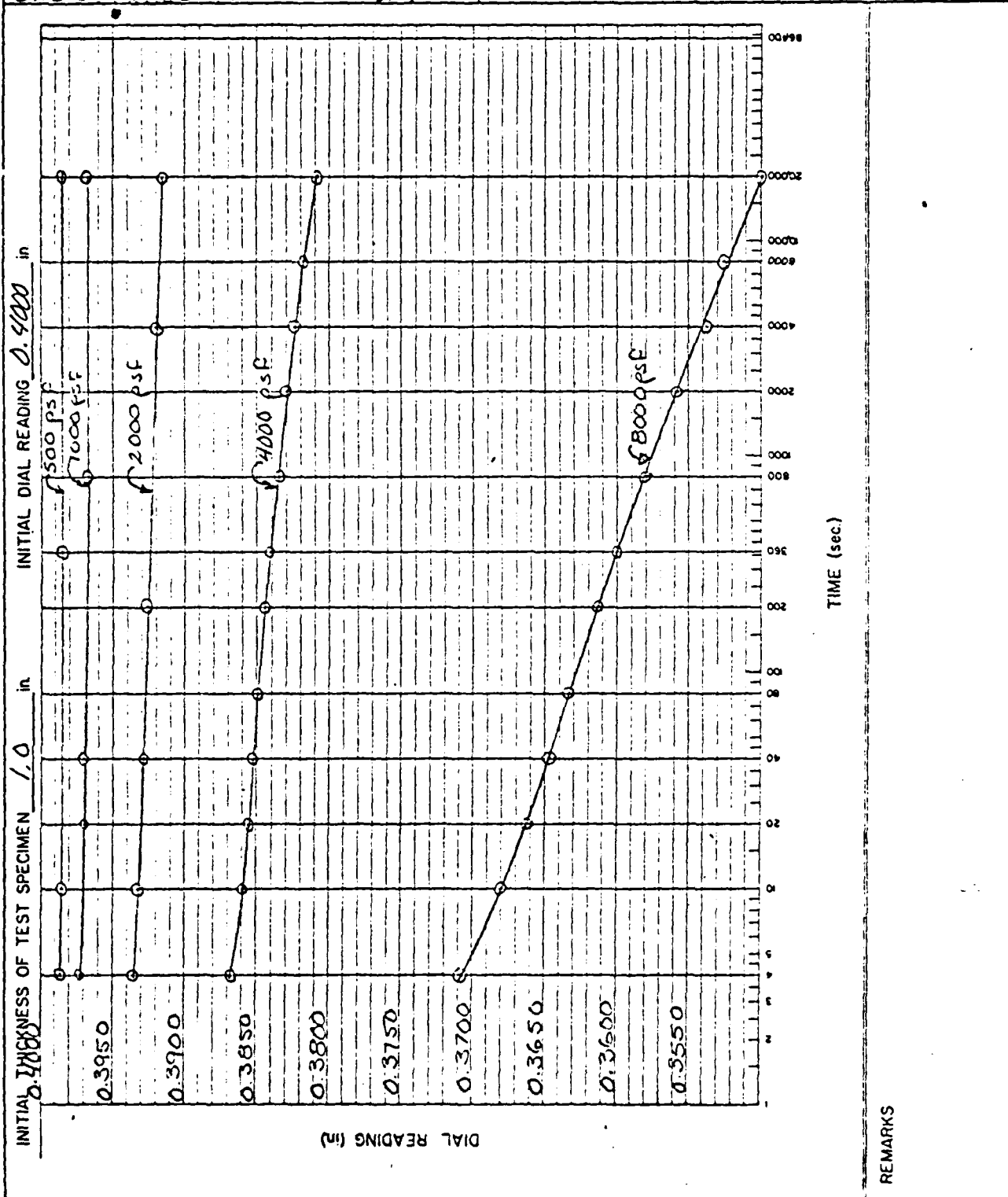
CLASSIFICATION _____ G_s <u>2.55</u> LL _____ PI _____ INITIAL DENSITY γ_d <u>1.18</u> INITIAL VOID RATIO, e_0 <u>1.1612</u> COMPRESSION INDEX, C_c _____	TEST SPECIFICATIONS:
--	----------------------



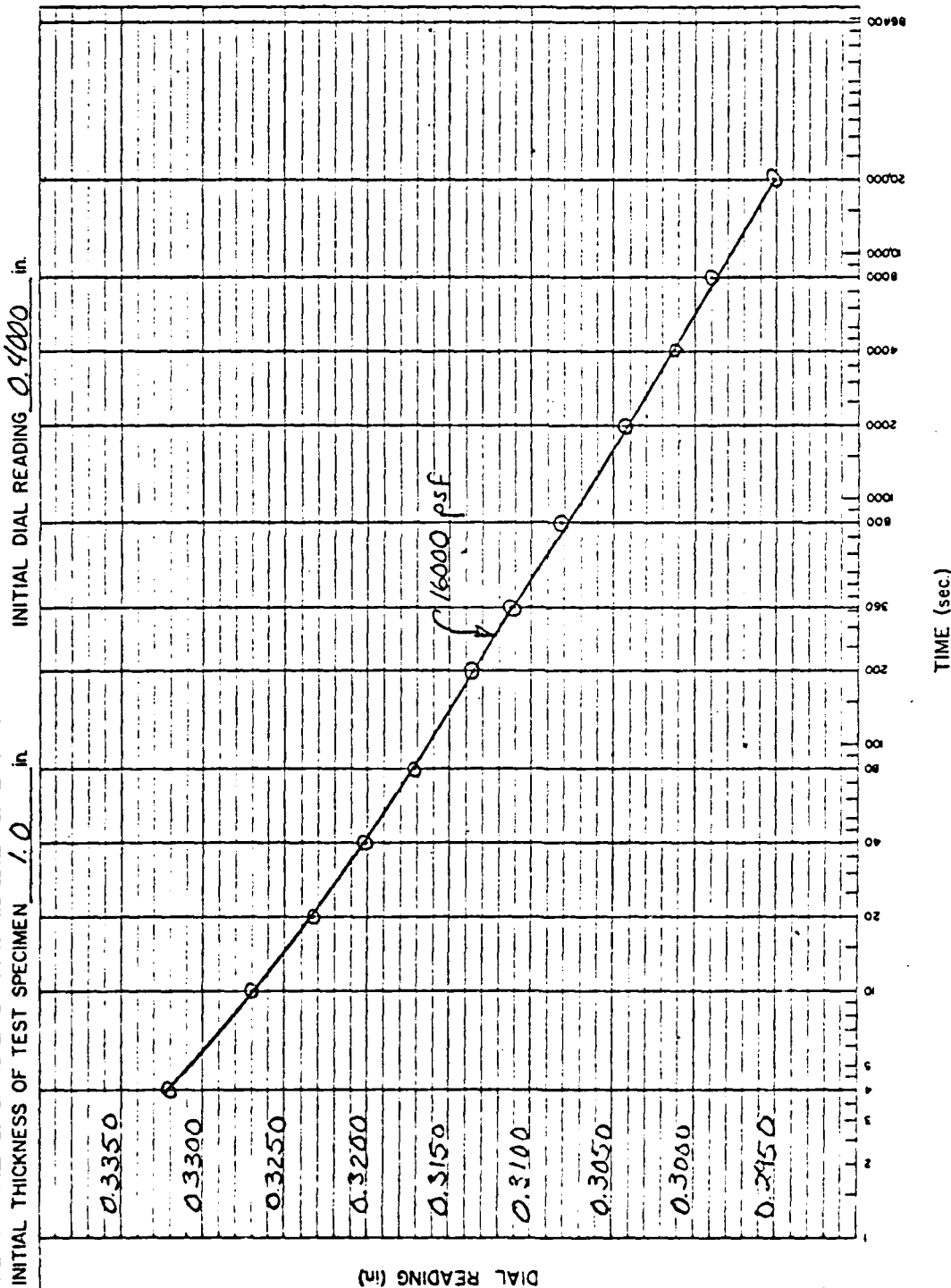
REMARKS

MATERIALS TESTING REPORT	U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE	LOG TIME CONSOLIDATION
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PROJECT and STATE <u>WELLINGTON - Napoleon, C-21 Missouri</u>		SAMPLE LOCATION	
FIELD SAMPLE NO.	DEPTH <u>22.0' - 23.5'</u>	GEOLOGIC ORIGIN	
TYPE OF SAMPLE <u>UNDISTURBED</u>	TESTED AT <u>SML - Lincoln</u>	APPROVED BY	DATE

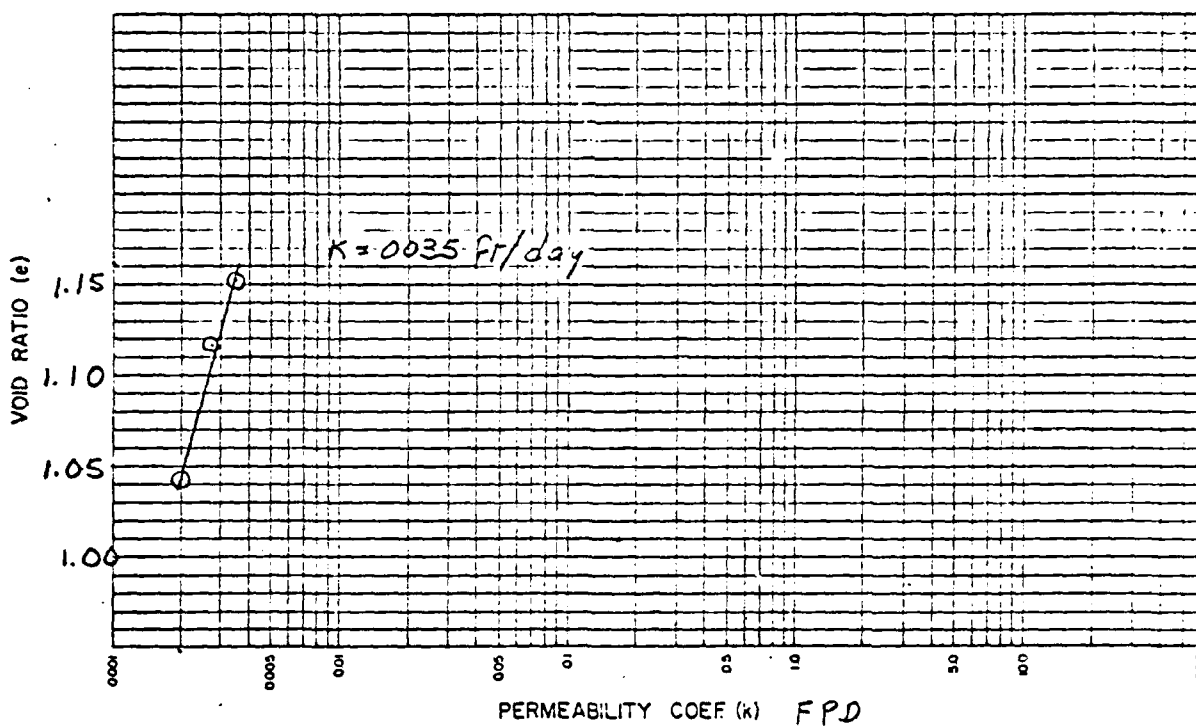


MATERIALS TESTING REPORT		U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE		LOG TIME CONSOLIDATION	
PROJECT and STATE WELLINGTON - NAPOLEON, C-21, Missouri				SAMPLE LOCATION	
FIELD SAMPLE NO.	DEPTH 22.0' - 23.5'	GEOLOGIC ORIGIN			
TYPE OF SAMPLE Undisturbed	TESTED AT SML - Lincoln	APPROVED BY		DATE	



REMARKS

MATERIALS TESTING REPORT		U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE		SOIL PERMEABILITY	
PROJECT and STATE WELLINGTON-NAPOLEON C-21-Missouri				SAMPLE LOCATION	
FIELD SAMPLE NO		DEPTH 22.0'-23.5'	GEOLOGIC ORIGIN		
TYPE OF SAMPLE UNDISTURBED		TESTED AT SML-LINCOLN	APPROVED BY		DATE
CLASSIFICATION LL ____ PI ____				SPECIFIC GRAVITY	
TEST NO.	1	2	3	4	$G_s (-)^{\#4}$
INITIAL MOISTURE %					$G_s (+)^{\#4}$
DRY DENSITY <input type="checkbox"/> g/cc <input type="checkbox"/> pcf					$G_m(Bulk)(+)^{\#4}$
VOID RATIO	1.1420	1.1177	1.0441		TEST SPECIFICATIONS
PERMEABILITY COEF	.0035	.0027	.0020		
PERCOLATION COEF					
H_L DURING TEST					



REMARKS

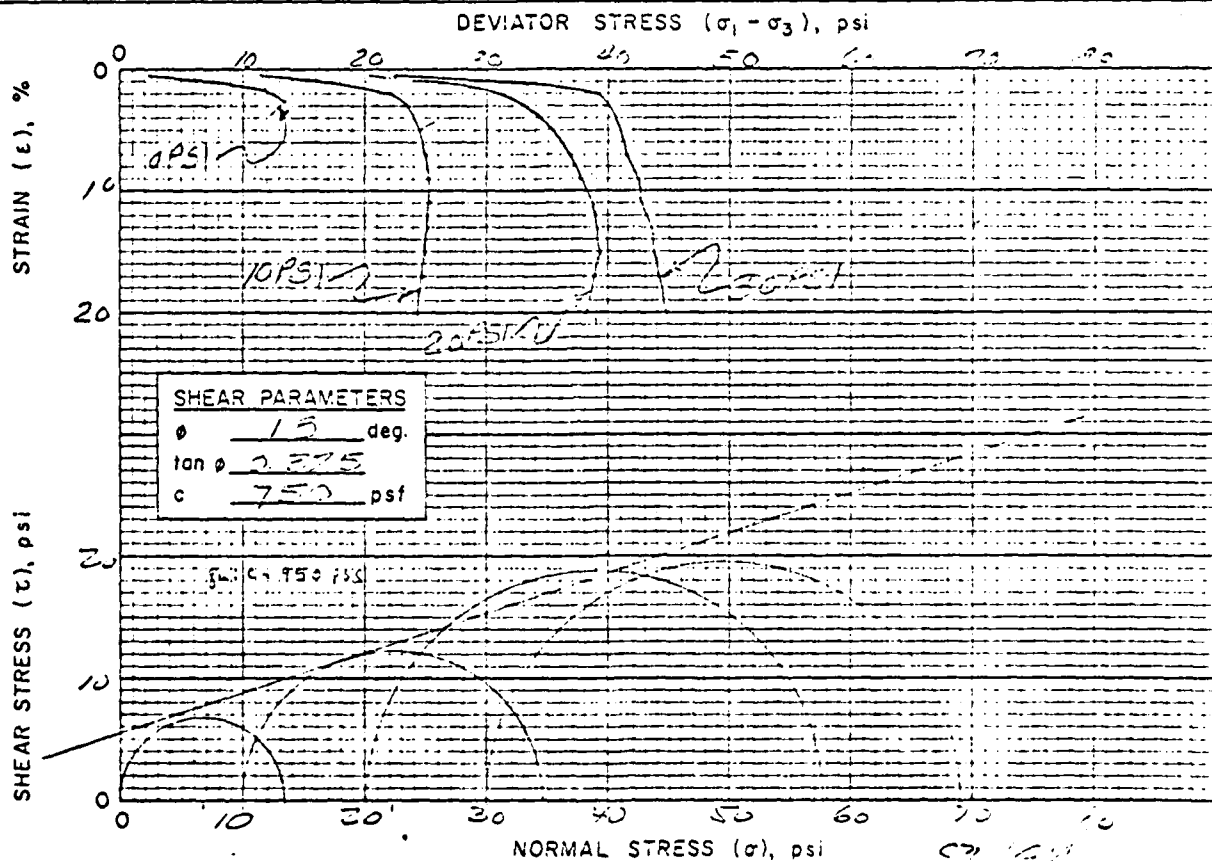
MATERIALS TESTING REPORT

U. S. DEPARTMENT of AGRICULTURE
SOIL CONSERVATION SERVICE

TRIAXIAL SHEAR TEST

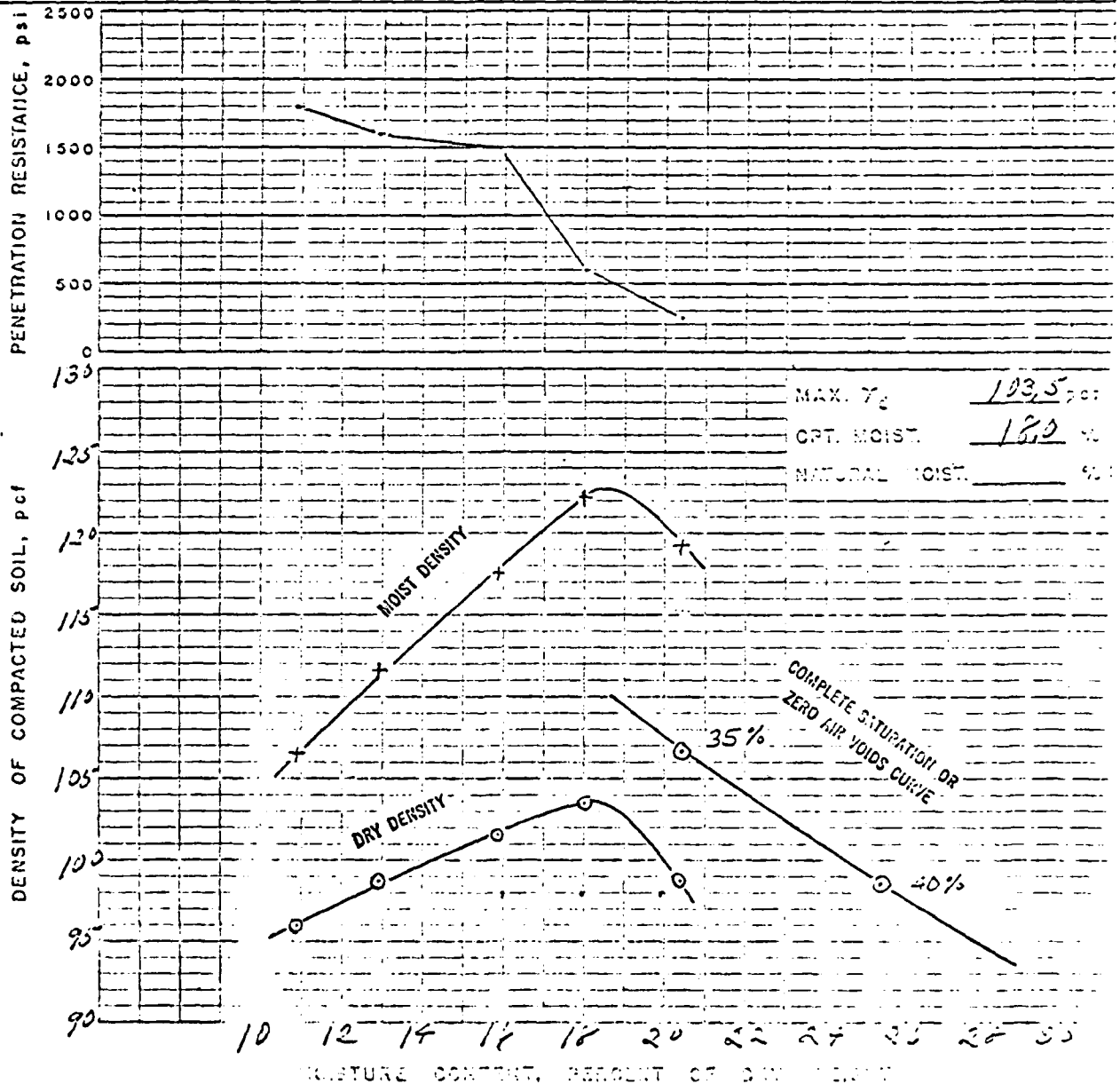
PROJECT AND STATE HAWAIIAN TERRITORY - HONOLULU, T.H. No. C-21 MISC-21		SAMPLE LOCATION 2 FILL 2-40	
FIELD SAMPLE NO. 301-9	DEPTH 10.0'-11.5'	GEOLOGIC ORIGIN	
TYPE OF SAMPLE UNDISTURBED	TESTED AT 500' - 1000'	APPROVED BY	DATE
INDEX TEST DATA		SPECIMEN DATA	
USCS <u>CL</u> ; LL <u>37</u> ; PI <u>13</u>		HEIGHT <u>5.0</u> "; DIAMETER <u>1.4</u> "	
% FINER (mm): 0.002 <u>15</u> ; 0.005 <u>23</u> ; 0.074 (#200) <u>93</u>		MATERIALS TESTED PASSED <u>#4</u> SIEVE	
G _s (-#4) <u>2.65</u> ; G _s (+#4) _____		METHOD OF PREPARATION <u>Hand mixed, oven dried</u>	
STANDARD: Y _d MAX. _____ pcf; w _o _____ %		MOLDING MOISTURE _____ %	
MODIFIED: Y _d MAX. _____ pcf; w _o _____ %		MOLDED AT _____ % OF Y _d MAXIMUM	
		UU <input type="checkbox"/> CU <input checked="" type="checkbox"/> CO <input type="checkbox"/> CD <input type="checkbox"/>	

DRY DENSITY		MOISTURE CONTENT, %			TIME OF CONSOLIDATION (hrs.)	MINOR PRINCIPAL STRESS σ_3 (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	AXIAL STRAIN AT FAILURE, ϵ (%)
INITIAL pcf <input type="checkbox"/> g/cc <input type="checkbox"/>	CONSOLIDATED pcf <input type="checkbox"/> g/cc <input type="checkbox"/>	START OF TEST	DEG. OF SAT. AT START OF TEST	END OF TEST				
1.25		21.4	70.0			0	13.5	2.7
1.27	1.22	22.6	59.4	25.2	10.52	10	12.5	5.0
1.50	1.37	30.2	47.0	29.5	10.60	20	27.7	9.0
1.240	1.255	23.0	58.0	24.0	10.37	20	23.7	2.0



REMARKS TESTED & NATURAL WOODS

MATERIALS TESTING REPORT		U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE		COMPACTION AND PENETRATION RESISTANCE	
PROJECT and STATE <u>Wellington-Napoleon #C-21</u> <u>Missouri</u>					
FIELD SAMPLE NO. <u>101.1</u>		LOCATION <u>Borrow A+50 : 4+50</u>			DEPTH <u>0.0'-5.0'</u>
GEOLOGIC ORIGIN		TESTED AT <u>SML-LINCOLN</u>		APPROVED BY	DATE
CLASSIFICATION <u>CL</u> <u>LL</u> <u>31</u> <u>PI</u> <u>10</u>				CURVE NO. <u>1</u> OF <u>4</u>	
MAX. PARTICLE SIZE INCLUDED IN TEST <u>< # 4"</u>				STD. (ASTM D-698) <input checked="" type="checkbox"/> METHOD <u>A</u>	
SPECIFIC GRAVITY (G_s) { MINUS NO. 4 <u>2.63</u>				MOD. (ASTM D-1557) <input type="checkbox"/> METHOD	
				PLUS NO. 4	
OTHER TEST <input type="checkbox"/> (SEE REMARKS)					



REMARKS

MATERIALS TESTING REPORT	U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	COMPACTION AND PENETRATION RESISTANCE
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PROJECT and STATE

Wellington-Napoleon #C-21 Missouri

FIELD SAMPLE NO.

102.1

LOCATION

Borrow 13+00 ; 5+00

DEPTH

1.0 - 2.0'

GEOLOGIC ORIGIN

TESTED AT

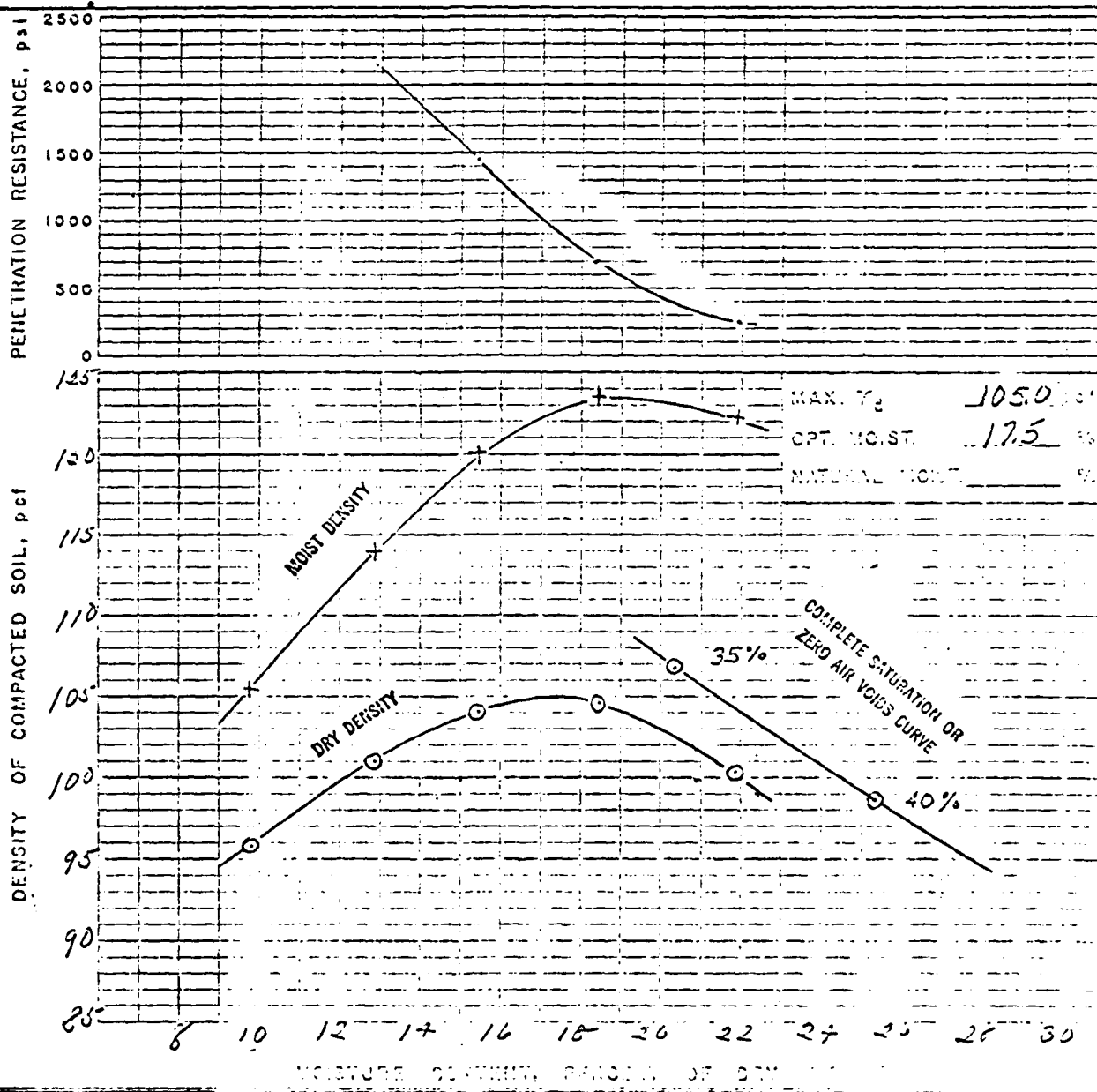
SML. LINCOLN

APPROVED BY

DATE

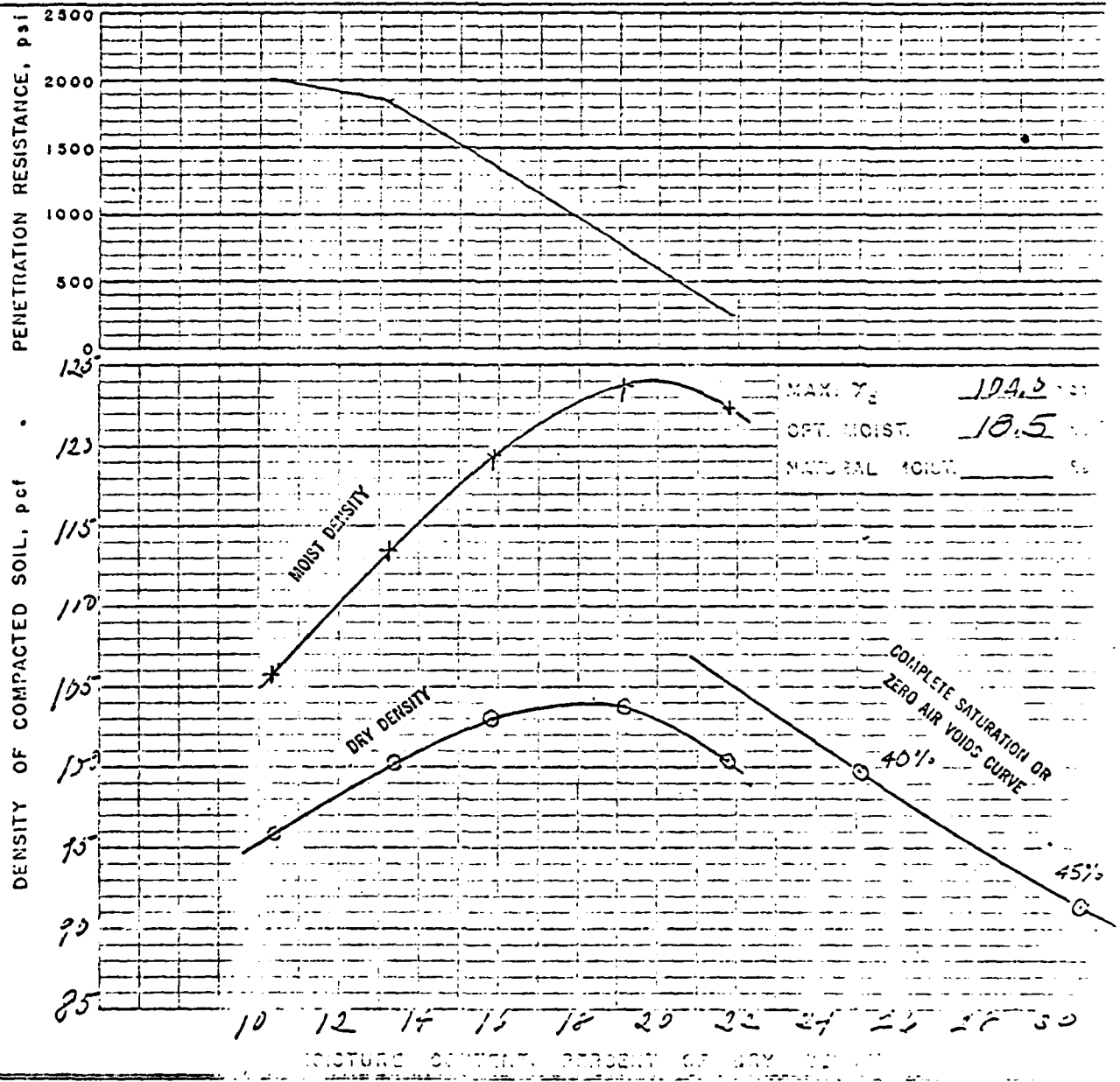
CLASSIFICATION CL LL 36 PI 16CURVE NO. 2 OF 4MAX. PARTICLE SIZE INCLUDED IN TEST < # 4"STD. (ASTM D-695) ☒ METHOD ASPECIFIC GRAVITY (G_s) { MINUS NO. 4 2.63

PLUS NO. 4

MOD. (ASTM D-1557) ☐ METHODOTHER TEST ☐ (SEE REMARKS)

REMARKS

MATERIALS		U. S. DEPARTMENT OF AGRICULTURE		COMPACTION AND	
TESTING REPORT		SOIL CONSERVATION SERVICE		PENETRATION RESISTANCE	
PROJECT AND STATE <u>Wellington - Napoleon # C-21</u> <u>Missouri</u>					
FIELD SAMPLE NO. <u>103.1</u>		LOCATION <u>Borrow C+00; 6+75</u>			DEPTH <u>0.0 - 4.0'</u>
GEOLOGIC ORIGIN		TESTED AT <u>SML - LINCOLN</u>		APPROVED BY	DATE
CLASSIFICATION <u>CL</u> <u>LL 39</u> <u>PI 13</u>		CURVE NO. <u>3</u> OF <u>4</u>			
MAX. PARTICLE SIZE INCLUDED IN TEST <u>< # 4"</u>		STD. (ASTM D-698) <input checked="" type="checkbox"/> METHOD <u>A</u>			
SPECIFIC GRAVITY (G _s) { MINUS NO. 4 <u>2.66</u>		MOD. (ASTM D-1557) <input type="checkbox"/> METHOD			
{ PLUS NO. 4		OTHER TEST <input type="checkbox"/> (SEE REMARKS)			



REMARKS

MATERIALS TESTING REPORT	U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	COMPACTION AND PENETRATION RESISTANCE
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PROJECT AND STATE Wellington - Napoleon # C-21 Missouri

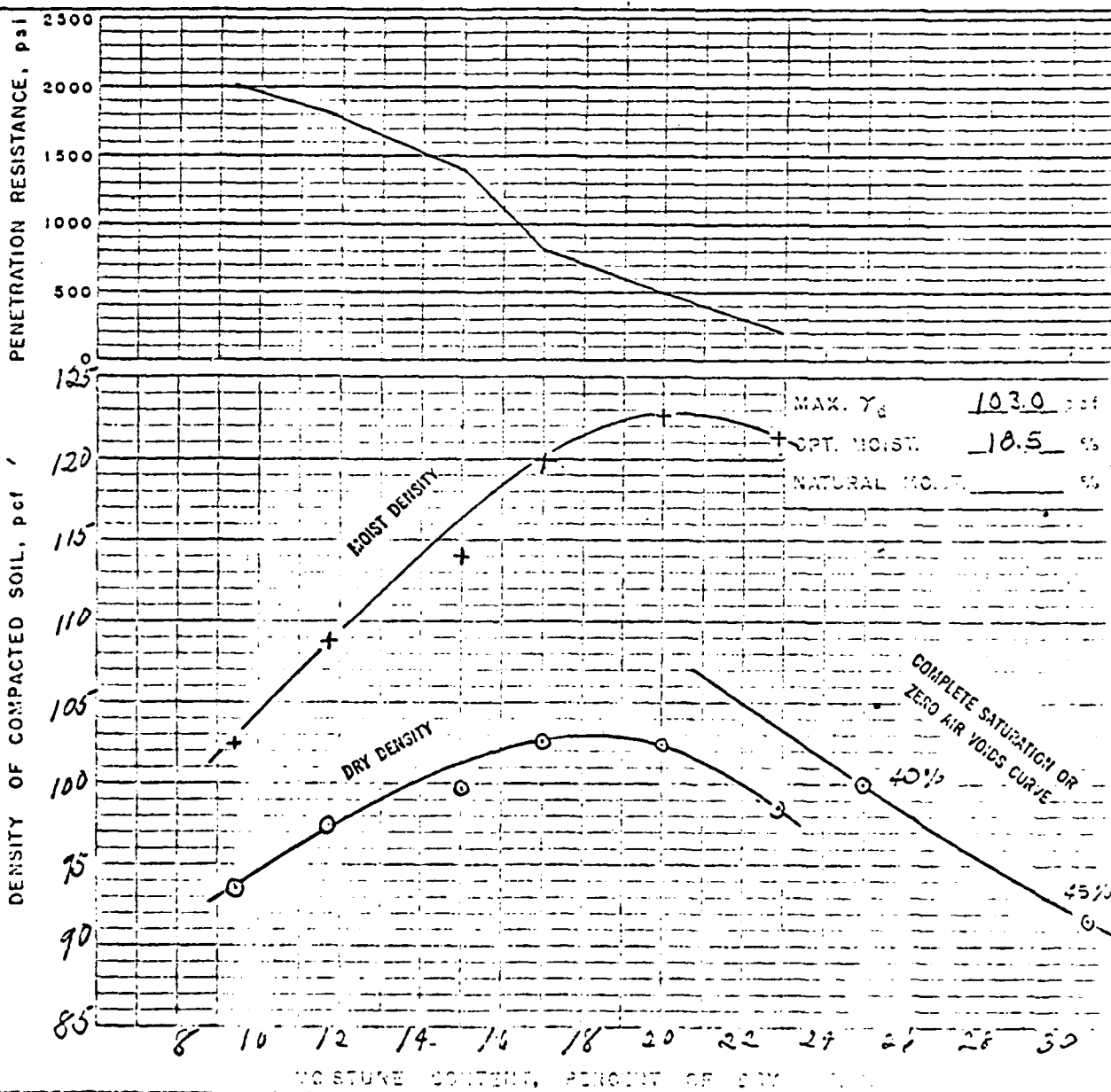
FIELD SAMPLE NO. 103.2 LOCATION Borrow C+00 ; 6+75 DEPTH 4.0-9.0'

GEOLOGIC ORIGIN _____ TESTED AT SMC-LINCOLN APPROVED BY _____ DATE _____

CLASSIFICATION CL LL 40 PI 17 CURVE NO. 4 OF 4

MAX. PARTICLE SIZE INCLUDED IN TEST < 4" STD. (ASTM D-698) ☒ METHOD A

SPECIFIC GRAVITY (G_s) { MINUS NO. 4 2.67 MOD. (ASTM D-1557) ☐ METHOD _____
PLUS NO. 4 _____ OTHER TEST ☐ (SEE REMARKS)

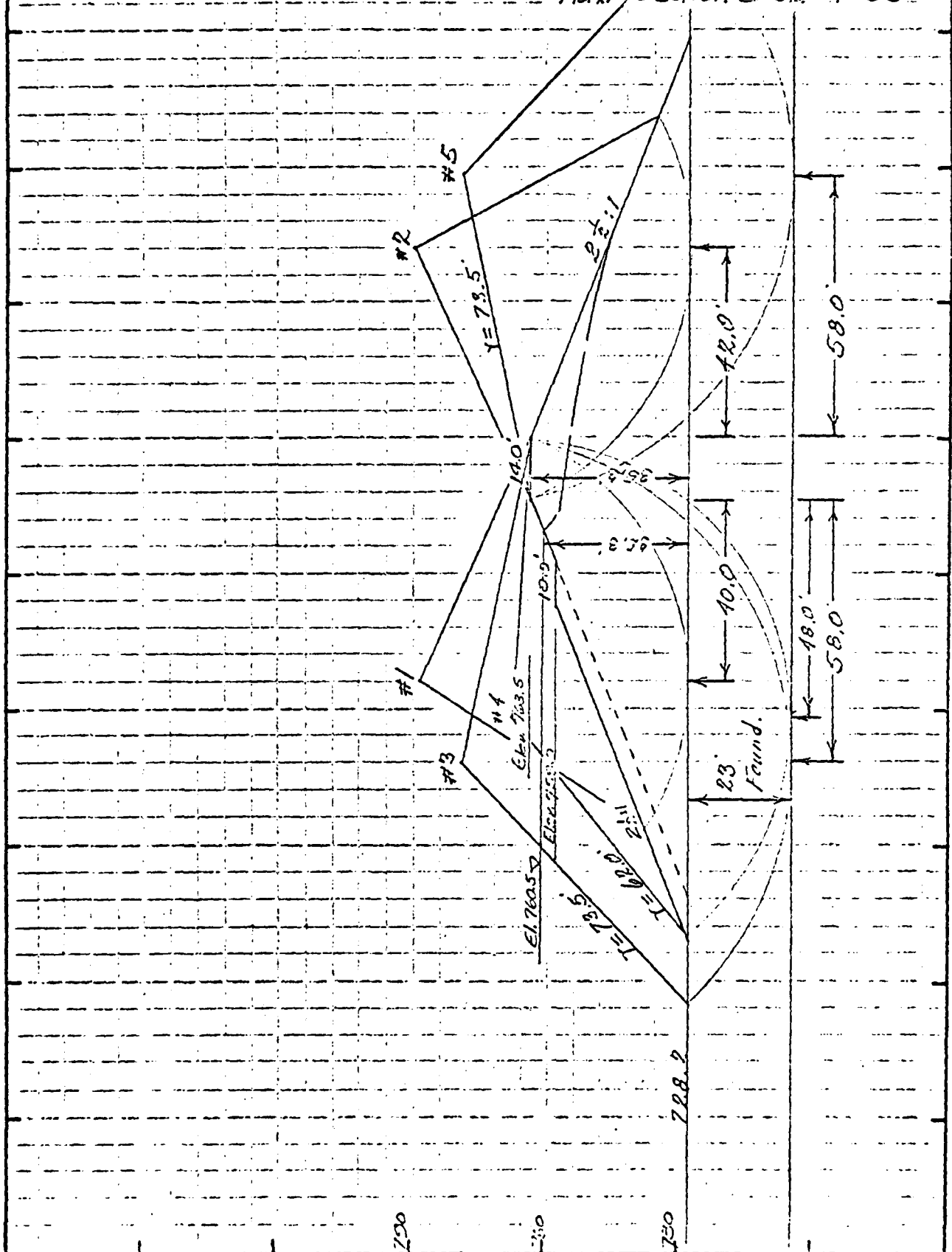


REMARKS

MATERIALS TESTING REPORT		U. S. DEPARTMENT of AGRICULTURE SOIL CONSERVATION SERVICE		SUMMARY - SLOPE STABILITY ANALYSIS				
PROJECT and STATE WELLINGTON-NAPOLEON SITE "C-21", MISSOURI				DATE 9-30-56				
METHODS OF ANALYSIS SWEDISH CIRCLE				ANALYZED AT S.M.L.; LINCOLN, NEBR.				
APPROVED BY								
SOURCE AND USE OF MATERIALS	CLASSIFICATION	ADOPTED DESIGN DATA				REMARKS		
		γ_d (pcf)	γ_m (pcf)	γ_{sub} (pcf)	ϕ (deg)	$\tan \phi$	c (psf)	
① Filled	CL	92.5		119.0	56.5	18.0	2325	750
② Emb (from site "C-23")	CL	96.8	115.0	121.5	93.0	10.0	2175	1150
③ Emb (from site "B-21")	CL	92.5	117.5	123.0	60.5	17.0	2325	925
④								
⑤								
⑥								
⑦								
⑧								
TRIAL NO.	SLOPE	CONDITIONS						
1	2:1	Maximum Section @ Station 3+80						
2	2:1	Full drawdown - No berm - Arc cut from opp. shoulder thru Emb (10°-1150) emb.						
3	2:1	Same as #1 but Emb (17°-925).						
4	2:1	No drain - No berm - Arc cut from opp. shoulder thru emb (17°-925) emb.						
5	2:1	Full drawdown - 10' berm @ center 1580 - Arc cut from opp. shoulder thru Emb (170°-925) & 230' Found (180°-750).						
6	2:1	Full drawdown - 10' berm @ center 1580 - Arc cut from opp. shoulder thru Emb (170°-925) & 230' Found (180°-750).						
7	2:1	No drain - No berm - Arc cut from opp. shoulder thru emb (170°-925) & 230' Found (180°-750).						
8	2:1							
9	2:1							
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99	2:1							
100	2:1							

Continuation of Sheet 1 of 2, 5000
 WELLINGTON-NAPOLEON #C-21
 Missouri

Max. Section @ Sta. 4+65



Scale: 1 inch = 5 Feet

10-59

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

GENERAL

State Missouri County Lafayette ; SW $\frac{1}{4}$ Sec. 20 T 50N R 23W ; Watershed Wellington-Napoleon
Subwatershed _____ Fund class WP-03-10 Site number C-21 Site group I Structure class b
(FP-2, WP-1, etc.)
Investigated by Nuel F. Edwards, Geo. Equipment used Mobile B-10 Date 6-16-66
(signature and title) (Type, size, make, model, etc.)

SITE DATA

Drainage area size 52 sq. mi., 333 acres. Type of structure DI 24" RC Purpose Stabilization, Sediment, Detention, FWR
Direction of valley trend (downstream) N Maximum height of fill 35.3 feet. Length of fill 495 feet.
Estimated volume of compacted fill required 20,500 yards

STORAGE ALLOCATION

	Volume (ac. ft.)	Surface Area (acres)	Depth at Dam (feet)
Sediment	<u>150</u>	<u>16.5</u>	<u>29.8</u>
Floodwater	<u>43.5</u>	<u>20.0</u>	<u>32.3</u>

SURFACE GEOLOGY AND PHYSIOGRAPHY

Physiographic description Mo. River Loess Hills Topography Rolling Attitude of beds: Dip ---- Strike ----
Steepness of abutments: Left 7 percent; Right 15 percent. Width of floodplain at centerline of dam 0 feet
General geology of site: The site is located in the Missouri River loess hills in rolling to strongly rolling topography. The underlying bedrock is the Upper Desmoinesian Series of the Pennsylvanian System and is characterized as cyclic deposits predominately limestone and shale.

10-59

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

FEATURE Centerline of Dam, Principal Spillway, Borrow Area

(Centerline of Dam, Principal Spillway, Emergency Spillway, the Stream Channel, Investigations for Drainage of Structure, Borrow Area, Reservoir Basin, etc.)

DRILLING PROGRAM

Equipment Used	Number of Holes		Number of Samples Taken		
	Exploration	Sampling	Undisturbed (state type)	Disturbed Large	Small
PA 4"	6	3		4 L. Bag	
Sp.T		4			19 Jar
Tube 3"		1	4 Shelby		
Total	6	8	4	4	19

SUMMARY OF FINDINGS

(include only factual data)

The abutments are deep loess classified CL below the developed soil profile. In test hole # 2 the loess was 30 feet deep and underlain with material classified as a stiff CH. The central section of the foundation adjacent to the channel is described as alluvium or a modified loess and is underlain with sand classified SP and SW at depths of 35 to 40 feet. The thickness of the sandy material ranges from 3 to 6 feet. Lens of material classified SM occurs in test holes 5 and 301. The weakest material in the foundation is the alluvium which had a blow count of 2 from 15 to 16 feet in test hole # 301. The foundation of the principal spillway is the alluvial material which had blow counts ranging from 2 to 5. The alluvium is underlain with a stiff ML described as an organic silt. SP or SW material was found at depth in all test holes on the centerline of the principal spillway. In test hole # 304, the SP was underlain with stiff clay classified CH. The emergency spillway cuts are shallow and will be in the loess soil. The gully at the centerline is active and cutting into undisturbed material. There is sufficient borrow available within 700 feet of the centerline of the fill.

10-59

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

State Missouri County Lafayette Watershed Wellington-Napoleon Subwatershed _____
Site number C-21 Site group I Structure class b Investigated by Nuel F. Edmonds, Geo. Date 6-16-66
(signature and title)

INTERPRETATIONS AND CONCLUSIONS

The abutments are deep loess and present no geologic problems. The loess below the developed soil profile has sufficient clay content to be classified (low) CL. The material in the central part of the foundation, described as alluvium, between approximate centerline stations 4+00 and 5+50, is variable in texture and strength. The weakest material in test hole # 301 had a blow count of 2 and is interpreted to extend beneath the channel and to approximate centerline station 5+00. The underlying material described as stiff organic silt extends to approximately the same distance. The alluvium in test hole # 4 to the right of the channel had blow counts of 6 in the upper part and ranged from 11 to 20 in the lower part. The foundation of the principal spillway is the soft to medium alluvium which extends to a depth of about 15 feet. This is underlain with a medium ML and the organic silts. The SM SP and SW material occurred consistently in all test holes through the alluvium and at a relatively uniform elevation. The SP material in test hole # 304 was underlain with a stiff clay and is assumed to underlie the sand encountered in the other test holes. Undisturbed samples of the different materials were taken in test hole # 301.

The channel is active at the centerline and to a 5 foot overfall approximately 50 feet upstream and has cut to undisturbed material. Above the overfall the channel averages 2 feet deep and 30 feet wide and has approximately 3 feet of soft silt and debris in the bottom. The overfall is active and could move through the foundation area before construction time. Since emergency spillway cuts are shallow and in a loess soil, it was not necessary to drill or sample.

Borrow area 103 is a loess soil and will be the best source of material for the core. Area 102 is high bottom or terrace alluvium and classified CL. Borrow area 101 is modern alluvium classified ML and was soft and wet below 6 feet. Estimated amounts of borrow available:

Hole No.	Cu/yds Topsoil	Cu/yds Compacted Fill
101	6000	----
102	1250	7500
103	--	6000
Emergency Spillway	1250	1250
Total	8500	14,750

APPENDIX D
HYDROLOGIC COMPUTATIONS

Note: Reproductions of Sheets 1 through 3 of 3 included in Appendix D are the best possible from copy furnished by Soil Conservation Service. Unreadable portions on the reproduced sheets are also unreadable on sheets from which the copies were made.

HYDROLOGIC COMPUTATIONS

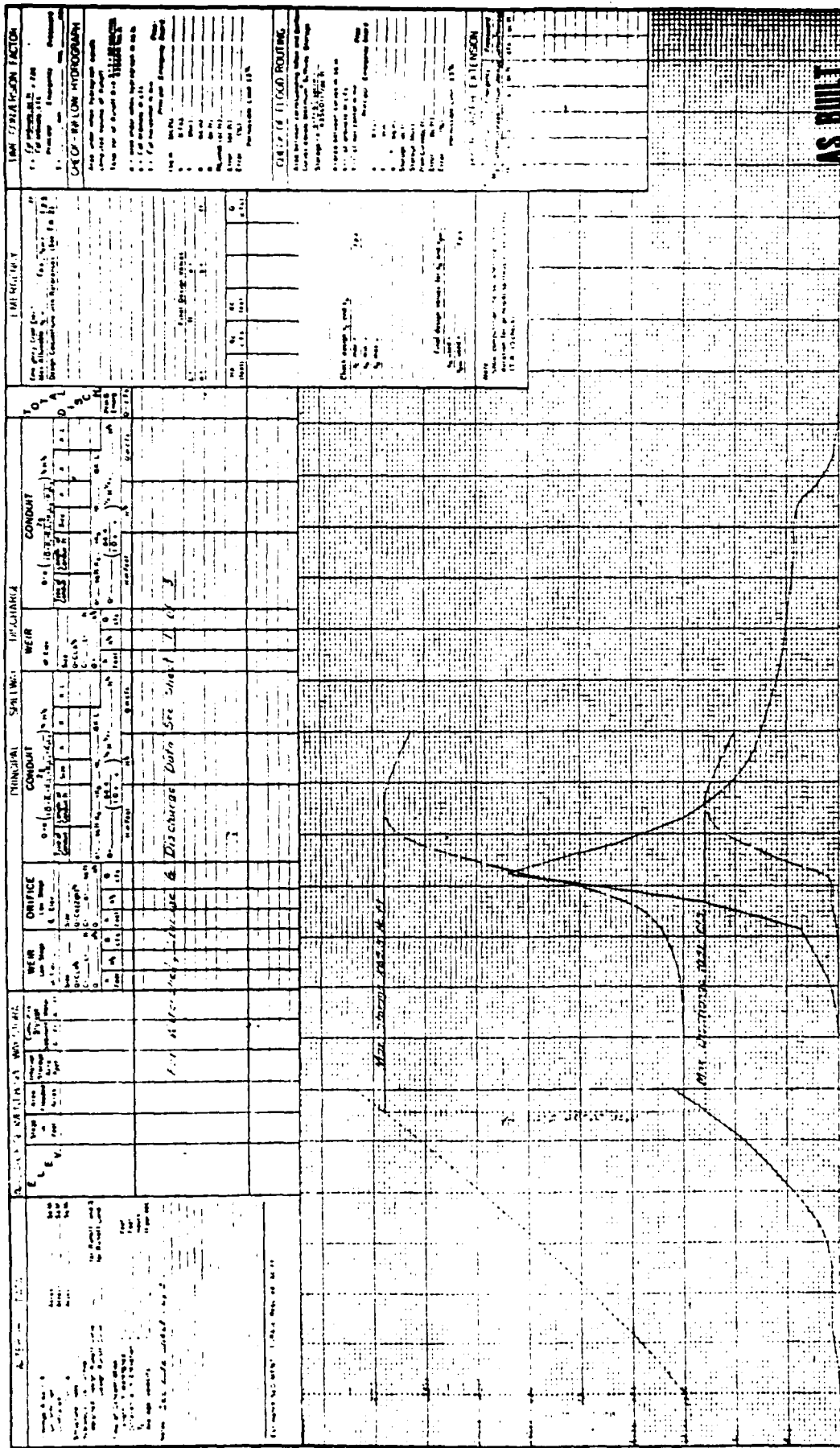
1. The Mockes dimensionless standard curvilinear unit hydrograph and the SCS TR-20 program were used to develop the inflow hydrographs (see Plate D1). The inflow hydrograph for the 100-year flood was also generated by the consultant using the TR-20 program.
 - a. Six-hour, twelve-hour, and twenty-four hour 100-year rainfall for the dam location was taken from NOAA Technical Paper 40. The 24-hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis District policy and guidance for hydraulics and hydrology.
 - b. Drainage area = 0.52 square mile; 333 acres (SCS).
 - c. Time of concentration of runoff = 20 minutes (SCS).
 - d. The antecedent storm conditions were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMCIII). The initial pool elevation was assumed at the crest of the principal spillway.
 - e. The total 24-hour storm duration losses for the 100-year storm were 1.77 inches. The total losses for the 24-hour duration 1/2 PMF storm were 1.96 inches. The total losses for the PMF storm were 2.05 inches. These data were based on use of soils group B; pasture/range and row crop weighted to produce SCS input runoff curve No. 70 from SCS AMCII converted by TR-20 to computed curve No. 85 SCS AMCIII.
 - f. Average soil loss rates = 0.05 inch per hour approximately.
2. The drop inlet and conduit discharge ratings were developed using standard formulas and criteria from SCS publication design manual EWP-5 taken from Corps of Engineers publication, "Hydraulic Characteristics of Reservoir Outlet Works". The emergency spillway rating was developed using the SCS emergency spillway computer program "RESIN"; the results compared closely with data shown on the SCS as-built plans. The flows over the dam crest were based on the broad-crested weir equation $Q = CLH^{3/2}$, where H is the head on the dam crest; the coefficient C, which varies with head, was taken from the USGS publication "TWRI, Book 3, Chapter 5, Measurement of Peak Discharge at Dams by Indirect Methods" (C valued varies from 2.52 to 3.00). Sample calculations are attached.
3. Floods were routed through the reservoir using the TR-20 program to determine the capabilities of the spillways and dam embankment crest. The unit hydrograph computation duration interval is computed as 0.17TC by the TR-20 computer program. Copies of the input-output data from the TR-20 program used to develop the hydrographs for the PMF, 0.5 PMF, and 100-year flood are attached. The storm rainfall patterns, inflow hydrographs and routed outflow hydrographs are shown on Plate D1.

FLOOD ROUTING

Time (hr)	Peak Discharge (cfs)
0	0
12	10,000
24	40,000
36	60,000
48	80,000
60	60,000
72	40,000
84	20,000
96	10,000
108	0

SUMMARY DATA

Time (hr)	Peak Discharge (cfs)
0	0
12	10,000
24	40,000
36	60,000
48	80,000
60	60,000
72	40,000
84	20,000
96	10,000
108	0



FLOOD ROUTING

HYDROGRAPH

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

SUMMARY DATA

Time (Hours)	Peak Discharge (cfs)	Time to Peak (Hours)	Base Flow (cfs)	Duration (Hours)
1	100	1	50	1
2	200	2	50	2
3	300	3	50	3
4	400	4	50	4
5	500	5	50	5
6	600	6	50	6
7	700	7	50	7
8	800	8	50	8
9	900	9	50	9
10	1000	10	50	10
11	900	11	50	11
12	800	12	50	12
13	700	13	50	13
14	600	14	50	14
15	500	15	50	15
16	400	16	50	16
17	300	17	50	17
18	200	18	50	18
19	100	19	50	19
20	50	20	50	20

Inflow Hydrograph Coordinates

Time (Hours)	Peak Discharge (cfs)	Time to Peak (Hours)	Base Flow (cfs)	Duration (Hours)
1	100	1	50	1
2	200	2	50	2
3	300	3	50	3
4	400	4	50	4
5	500	5	50	5
6	600	6	50	6
7	700	7	50	7
8	800	8	50	8
9	900	9	50	9
10	1000	10	50	10
11	900	11	50	11
12	800	12	50	12
13	700	13	50	13
14	600	14	50	14
15	500	15	50	15
16	400	16	50	16
17	300	17	50	17
18	200	18	50	18
19	100	19	50	19
20	50	20	50	20

STRUCTURE DATA

[illegible]

CHANNEL HYDRAULICS

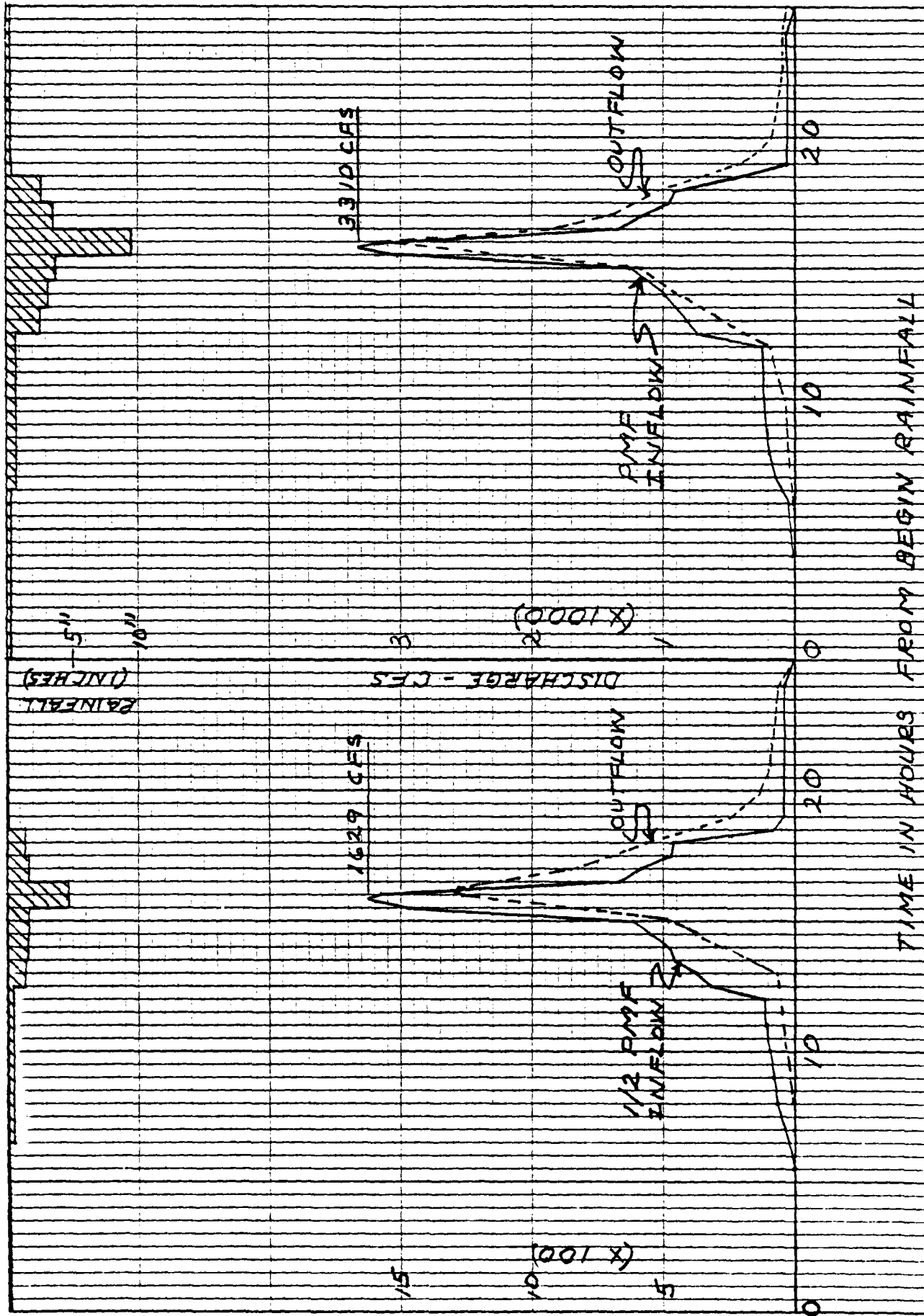
[illegible]

AS BUILT

GENERAL DESIGN DATA	1000
STRUCTURE C-21	1000
MELTING/HARLEON WATERSED R-566	1000
LAFAYETTE COUNTY, MISSOURI	1000
U.S. DEPARTMENT OF AGRICULTURE	1000
SOIL CONSERVATION SERVICE	1000

(Annual) Review based on SES-7461; velocities based on "U" Interchange. Data based on "A" Releasance.

#10284



HYDROLOGY PROGRAM FOR IDH 1130 - DATED JULY, 1960

MO DAM INSP LAFAYETTE C-21 DAM (SCS) EXECUTIVE CONTROL CARD

MO DAM INSP LAFAYETTE C-21 DAM (SCS)

C TABLE VFLUCITY INCREMENT = 0.200

0	0.0000	0.0800	0.1600	0.2500	0.3200
0	0.0700	0.1500	0.2300	0.3100	0.3900
0	0.1400	0.2200	0.3000	0.3800	0.4600
0	0.2100	0.2900	0.3700	0.4500	0.5300
0	0.2800	0.3600	0.4400	0.5200	0.6000
0	0.3500	0.4300	0.5100	0.5900	0.6700
0	0.4200	0.5000	0.5800	0.6600	0.7400
0	0.4900	0.5700	0.6500	0.7300	0.8100
0	0.5600	0.6400	0.7200	0.8000	0.8800
0	0.6300	0.7100	0.7900	0.8700	0.9500
0	0.7000	0.7800	0.8600	0.9400	1.0200
0	0.7700	0.8500	0.9300	1.0100	1.0900
0	0.8400	0.9200	1.0000	1.0800	1.1600
0	0.9100	0.9900	1.0700	1.1500	1.2300
0	0.9800	1.0600	1.1400	1.2200	1.3000
0	1.0500	1.1300	1.2100	1.2900	1.3700
0	1.1200	1.2000	1.2800	1.3600	1.4400
0	1.1900	1.2700	1.3500	1.4300	1.5100
0	1.2600	1.3400	1.4200	1.5000	1.5900
0	1.3300	1.4100	1.4900	1.5700	1.6500
0	1.4000	1.4800	1.5600	1.6400	1.7200
0	1.4700	1.5500	1.6300	1.7100	1.7900
0	1.5400	1.6200	1.7000	1.7800	1.8600
0	1.6100	1.6900	1.7700	1.8500	1.9300
0	1.6800	1.7600	1.8400	1.9200	2.0000
0	1.7500	1.8300	1.9100	1.9900	2.0700
0	1.8200	1.9000	1.9800	2.0600	2.1400
0	1.8900	1.9700	2.0500	2.1300	2.2100
0	1.9600	2.0400	2.1200	2.2000	2.2800
0	2.0300	2.1100	2.1900	2.2700	2.3500
0	2.1000	2.1800	2.2600	2.3400	2.4200
0	2.1700	2.2500	2.3300	2.4100	2.4900
0	2.2400	2.3200	2.4000	2.4800	2.5600
0	2.3100	2.3900	2.4700	2.5500	2.6300
0	2.3800	2.4600	2.5400	2.6200	2.7000
0	2.4500	2.5300	2.6100	2.6900	2.7700
0	2.5200	2.6000	2.6800	2.7600	2.8400
0	2.5900	2.6700	2.7500	2.8300	2.9100
0	2.6600	2.7400	2.8200	2.9000	2.9800
0	2.7300	2.8100	2.8900	2.9700	3.0500
0	2.8000	2.8800	2.9600	3.0400	3.1200
0	2.8700	2.9500	3.0300	3.1100	3.1900
0	2.9400	3.0200	3.1000	3.1800	3.2600
0	3.0100	3.0900	3.1700	3.2500	3.3300
0	3.0800	3.1600	3.2400	3.3200	3.4000
0	3.1500	3.2300	3.3100	3.3900	3.4700
0	3.2200	3.3000	3.3800	3.4600	3.5400
0	3.2900	3.3700	3.4500	3.5300	3.6100
0	3.3600	3.4400	3.5200	3.6000	3.6800
0	3.4300	3.5100	3.5900	3.6700	3.7500
0	3.5000	3.5800	3.6600	3.7400	3.8200
0	3.5700	3.6500	3.7300	3.8100	3.8900
0	3.6400	3.7200	3.8000	3.8800	3.9600
0	3.7100	3.7900	3.8700	3.9500	4.0300
0	3.7800	3.8600	3.9400	4.0200	4.1000
0	3.8500	3.9300	4.0100	4.0900	4.1700
0	3.9200	4.0000	4.0800	4.1600	4.2400
0	3.9900	4.0700	4.1500	4.2300	4.3100
0	4.0600	4.1400	4.2200	4.3000	4.3800
0	4.1300	4.2100	4.2900	4.3700	4.4500
0	4.2000	4.2800	4.3600	4.4400	4.5200
0	4.2700	4.3500	4.4300	4.5100	4.5900
0	4.3400	4.4200	4.5000	4.5800	4.6600
0	4.4100	4.4900	4.5700	4.6500	4.7300
0	4.4800	4.5600	4.6400	4.7200	4.8000
0	4.5500	4.6300	4.7100	4.7900	4.8700
0	4.6200	4.7000	4.7800	4.8600	4.9400
0	4.6900	4.7700	4.8500	4.9300	5.0100
0	4.7600	4.8400	4.9200	5.0000	5.0800
0	4.8300	4.9100	4.9900	5.0700	5.1500
0	4.9000	4.9800	5.0600	5.1400	5.2200
0	4.9700	5.0500	5.1300	5.2100	5.2900
0	5.0400	5.1200	5.2000	5.2800	5.3600
0	5.1100	5.1900	5.2700	5.3500	5.4300
0	5.1800	5.2600	5.3400	5.4200	5.5000
0	5.2500	5.3300	5.4100	5.4900	5.5700
0	5.3200	5.4000	5.4800	5.5600	5.6400
0	5.3900	5.4700	5.5500	5.6300	5.7100
0	5.4600	5.5400	5.6200	5.7000	5.7800
0	5.5300	5.6100	5.6900	5.7700	5.8500
0	5.6000	5.6800	5.7600	5.8400	5.9200
0	5.6700	5.7500	5.8300	5.9100	5.9900
0	5.7400	5.8200	5.9000	5.9800	6.0600
0	5.8100	5.8900	5.9700	6.0500	6.1300
0	5.8800	5.9600	6.0400	6.1200	6.2000
0	5.9500	6.0300	6.1100	6.1900	6.2700
0	6.0200	6.1000	6.1800	6.2600	6.3400
0	6.0900	6.1700	6.2500	6.3300	6.4100
0	6.1600	6.2400	6.3200	6.4000	6.4800
0	6.2300	6.3100	6.3900	6.4700	6.5500
0	6.3000	6.3800	6.4600	6.5400	6.6200
0	6.3700	6.4500	6.5300	6.6100	6.6900
0	6.4400	6.5200	6.6000	6.6800	6.7600
0	6.5100	6.5900	6.6700	6.7500	6.8300
0	6.5800	6.6600	6.7400	6.8200	6.9000
0	6.6500	6.7300	6.8100	6.8900	6.9700
0	6.7200	6.8000	6.8800	6.9600	7.0400
0	6.7900	6.8700	6.9500	7.0300	7.1100
0	6.8600	6.9400	7.0200	7.1000	7.1800
0	6.9300	7.0100	7.0900	7.1700	7.2500
0	7.0000	7.0800	7.1600	7.2400	7.3200
0	7.0700	7.1500	7.2300	7.3100	7.3900
0	7.1400	7.2200	7.3000	7.3800	7.4600
0	7.2100	7.2900	7.3700	7.4500	7.5300
0	7.2800	7.3600	7.4400	7.5200	7.6000
0	7.3500	7.4300	7.5100	7.5900	7.6700
0	7.4200	7.5000	7.5800	7.6600	7.7400
0	7.4900	7.5700	7.6500	7.7300	7.8100
0	7.5600	7.6400	7.7200	7.8000	7.8800
0	7.6300	7.7100	7.7900	7.8700	7.9500
0	7.7000	7.7800	7.8600	7.9400	8.0200
0	7.7700	7.8500	7.9300	8.0100	8.0900
0	7.8400	7.9200	8.0000	8.0800	8.1600
0	7.9100	7.9900	8.0700	8.1500	8.2300
0	7.9800	8.0600	8.1400	8.2200	8.3000
0	8.0500	8.1300	8.2100	8.2900	8.3700
0	8.1200	8.2000	8.2800	8.3600	8.4400
0	8.1900	8.2700	8.3500	8.4300	8.5100
0	8.2600	8.3400	8.4200	8.5000	8.5800
0	8.3300	8.4100	8.4900	8.5700	8.6500
0	8.4000	8.4800	8.5600	8.6400	8.7200
0	8.4700	8.5500	8.6300	8.7100	8.7900
0	8.5400	8.6200	8.7000	8.7800	8.8600
0	8.6100	8.6900	8.7700	8.8500	8.9300
0	8.6800	8.7600	8.8400	8.9200	9.0000
0	8.7500	8.8300	8.9100	8.9900	9.0700
0	8.8200	8.9000	8.9800	9.0600	9.1400
0	8.8900	8.9700	9.0500	9.1300	9.2100
0	8.9600	9.0400	9.1200	9.2000	9.2800
0	9.0300	9.1100	9.1900	9.2700	9.3500
0	9.1000	9.1800	9.2600	9.3400	9.4200
0	9.1700	9.2500	9.3300	9.4100	9.4900
0	9.2400	9.3200	9.4000	9.4800	9.5600
0	9.3100	9.3900	9.4700	9.5500	9.6300
0	9.3800	9.4600	9.5400	9.6200	9.7000
0	9.4500	9.5300	9.6100	9.6900	9.7700
0	9.5200	9.6000	9.6800	9.7600	9.8400
0	9.5900	9.6700	9.7500	9.8300	9.9100
0	9.6600	9.7400	9.8200	9.9000	9.9800
0	9.7300	9.8100	9.8900	9.9700	1.0500
0	9.8000	9.8800	9.9600	1.0400	1.1200
0	9.8700	9.9500	1.0300	1.1100	1.1900
0	9.9400	1.0200	1.1000	1.1800	1.2600
0	1.0100	1.0900	1.1700	1.2500	1.3300
0	1.0800	1.1600	1.2400	1.3200	1.4000
0	1.1500	1.2300	1.3100	1.3900	1.4700
0	1.2200	1.3000	1.3800	1.4600	1.5400
0	1.2900	1.3700	1.4500	1.5300	1.6100
0	1.3600	1.4400	1.5200	1.6000	1.6800
0	1.4300	1.5100	1.5900	1.6700	1.7500
0	1.5000	1.5800	1.6600	1.7400	1.8200
0	1.5700	1.6500	1.7300	1.8100	1.8900
0	1.6400	1.7200	1.8000	1.8800	1.9600
0	1.7100	1.7900	1.8700	1.9500	2.0300
0	1.7800	1.8600	1.9400	2.0200	2.1000
0	1.8500	1.9300	2.0100	2.0900	2.1700
0	1.9200	2.0000	2.0800	2.1600	2.2400
0	1.9900	2.0700	2.1500	2.2300	2.3100
0	2.0600	2.1400	2.2200	2.3000	2.3800
0	2.1300	2.2100	2.2900	2.3700	2.4500
0	2.2000	2.2800	2.3600	2.4400	2.5200
0	2.2700	2.3500	2.4300	2.5100	2.5900
0	2.3400	2.4200	2.5000	2.5800	2.6600
0	2.4100	2.4900	2.5700	2.6500	2.7300
0	2.4800	2.5600	2.6400	2.7200	2.8000
0	2.5500	2.6300	2.7100	2.7900	2.8700
0	2.6200	2.7000	2.7800	2.8600	2.9400
0	2.6900	2.7700	2.8500	2.9300	3.0100
0	2.7600	2.8400	2.9200	3.0000	3.0800
0	2.8300	2.9100	2.9900	3.0700	3.1500
0	2.9000	2.9800	3.0600	3.1400	3.2200
0	2.9700	3.0500	3.1300	3.2100	3.2900
0	3.0400	3.1200	3.2000	3.2800	3.3600
0	3.1100	3.1900	3.2700	3.3500	3.4300
0	3.1800	3.2600	3.3400	3.4200	3.5000
0	3.2500	3.3300	3.4100	3.4900	3.5700
0	3.3200	3.4000	3.4800	3.5600	3.6400
0	3.3900	3.4700	3.5500	3.6300	3.7100
0	3.4600	3.5400	3.6200	3.7000	3.7800
0	3.5300	3.6100	3.6900	3.7700	3.8500
0	3.6000	3.6800	3.7600	3.8400	3.9200
0	3.6700	3.7500	3.8300	3.9100	3.9900
0	3.7400	3.8200	3.9000	3.9800	4.0600
0	3.8100</				

STANDARD CONTROL INSTRUCTIONS

SURPH	KSECTN	SIRCT	INI	IN2	OUT	DATA NO. 1	DATA NO. 2	DATA NO. 3	PK	OUTPUT	OPTION
RUNOFF	0	1	0	0	6	0.520	70.000	0.300	1	1	1
RESVOR	0	1	6	0	7	758.000	0.000	0.000	1	1	3
ENDATA											

END OF LISTING

ADDITIONS TO TABULAR DATA FOLLOW

STRUCTURE NO. 1

758.00001	0.0000	150.0000
758.0000	9.4000	155.0000
758.0000	27.0000	163.0000
759.0000	49.0000	170.0000
759.0000	54.0000	179.0000
760.00001	55.0000	185.0000
760.0000	56.0000	195.0000
760.7000	73.0000	198.0000
761.0000	93.0000	205.0000
761.50001	191.0000	212.0000
762.00001	340.0000	222.0000
763.00001	744.0000	232.0000
763.0000	1361.0000	263.0000
764.0000	1361.0002	280.0000
764.50001	1668.0002	292.0000
764.7000	1882.0002	297.0000
765.00001	2319.0004	304.0000
765.50001	3631.0004	318.0000
766.00001	5209.0009	332.0000

EXECUTIVE CONTROL CARD
EXECUTIVE CONTROL CARD
STARTING TIME = 0.00
ALTERNATE NO. = 1

MAIN TIME INCREMENT = 0.25
FROM XSCTN/STRUCT
RAIN DURATION = 1.00

TO XSCTN/STRUCT
RAIN TABLE NO. = 3

SUBROUTINE RUNOFF

AREA = 0.52

STRUCTURE NO. = 1

INPUT RUNOFF CURVE = 70.0

TIME OF CONCENTRATION = 0.54

PEAK TIMES

10.10

11.06

15.87

19.99

23.62

PEAK DISCHARGES

237.406

244.721

3313.734

79.662

73.587

HYDROGRAPH, TZERO = 2.75

2.59

16.46

200.19

236.17

416.67

3027.23

926.39

75.12

75.57

0.00

DELTA T = 0.25

9.96

123.03

213.95

243.21

997.47

1354.24

80.76

75.56

75.57

75.57

DELTA T = 0.25

10.93

145.89

223.40

246.11

117.73

1710.73

77.70

75.56

75.57

55.67

IMMEDIATE AREA = 0.52

11.70

13.40

174.57

235.17

530.83

1251.69

1022.03

77.70

75.56

75.57

1.02

ACML-11 = 837.39

SUBROUTINE RESOR

STRUCTURE NO. = 1

PEAK TIMES

15.93

15.93

15.93

15.93

15.93

15.93

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17.75	DISCHG	1005.79	1024.50	908.65	714.17	543.79	412.46	320.59	261.47	216.69	106.73
17.75	ELEV	763.61	763.51	763.30	762.92	762.50	762.17	761.93	761.75	761.57	761.46
20.25	DISCHG	168.95	153.63	140.56	129.59	120.42	112.74	106.32	100.96	97.85	96.08
20.25	ELEV	761.36	761.28	761.21	761.16	761.11	761.07	761.03	761.01	760.98	760.96
22.75	DISCHG	94.40	92.86	91.43	90.11	88.89	87.74	85.28	80.53	74.85	67.55
22.75	ELEV	760.94	760.92	760.91	760.89	760.88	760.87	760.84	760.78	760.72	760.63
25.25	DISCHG	60.08	55.95	55.83	55.72	55.60	55.49	55.37	55.26	55.14	55.03
25.25	ELEV	760.54	760.47	760.41	760.36	760.30	760.24	760.18	760.13	760.07	760.01

TOTAL WATER, IN INCHES ON DRAINAGE AREA= 28.8619 CFS-HRS= 9605.83 ACHE-FI= 800.43

ENDCMP 1

EXECUTIVE CONTROL CARD
STARTING TIME = 0.00
ALTERNATE NO. = 1

OPERATION COMPUT.
RAIN DEPTH = 0.50
STORM NO. = 4

FROM XSECTN/STRUCT
RAIN DURATION = 1.00

0/ 1
RAII TAII F NO. = 3

TO XSECTN/STRUCT
SOIL CONDITION = 3

SUBROUTINE RUNOFF
AREA = 0.52
COMPUTED CURVE NO. = 1

STRUCTURE INPUT
RUNOFF CURVE = 70.0
TIME OF CONCENTRATION = 0.34

PEAK DISCHARGES
PEAK ELEVATIONS
(HURIOFF)
(HURIOFF)
(HURIOFF)

0.5 PMF

PEAK TIMES
13.88
19.59
23.62

PEAK ELEVATIONS
(HURIOFF)
(HURIOFF)
(HURIOFF)

TIME	DISCHG	0.00	HYDROGRAPH, TZERO = 5.50	DELTA T = 0.25	41.66	0.52
5.50	DISCHG	67.06	1.40	22.58	32.87	55.96
10.50	DISCHG	97.92	71.71	82.97	49.28	96.92
13.50	DISCHG	374.82	100.83	104.30	92.52	56.82
15.50	DISCHG	1480.11	420.09	103.50	234.65	537.43
18.50	DISCHG	459.32	1571.85	467.28	603.65	614.48
20.50	DISCHG	36.77	242.36	669.20	520.97	471.05
23.00	DISCHG	36.50	36.50	40.06	38.24	39.52
				36.50	36.50	36.50
				36.50	0.50	0.04
				36.50	0.50	0.00

TOTAL WATER, IN INCHES ON DRAINAGE AREA = 14.1623 CFS-HRS = 4752.18 ACNE-FI = 392.77

SUBROUTINE RESVOR STRUCTURE
SURFACE ELEVATION = 758.00

PEAK TIMES
16.15

TIME	DISCHG	0.00	HYDROGRAPH, TZERO = 5.50	DELTA T = 0.25	2.76	0.52
5.50	DISCHG	758.00	0.02	0.77	1.63	5.67
10.50	DISCHG	758.00	0.07	758.03	758.11	758.24
13.50	DISCHG	758.00	758.00	758.03	758.11	758.24
15.50	DISCHG	758.00	758.00	758.03	758.11	758.24
18.50	DISCHG	758.00	758.00	758.03	758.11	758.24
20.50	DISCHG	758.00	758.00	758.03	758.11	758.24
23.00	DISCHG	758.00	758.00	758.03	758.11	758.24
25.50	DISCHG	758.00	758.00	758.03	758.11	758.24
28.00	DISCHG	758.00	758.00	758.03	758.11	758.24

TOTAL WATER, IN INCHES ON DRAINAGE AREA = 13.5221 CFS-HRS = 4547.91 ACNE-FI = 375.01

ENDUMP 1

EXECUTIVE CONTROL CARD
STARTING TIME = 0.00
ALTERNATE NO. = 1
OPERATION COMPUT.
RAIN DEPTH = 1.00
STORM NO. = 1
FROM XSECTN/SINUCT 0/1
RAIN DURATION = 1.00
RAIL TABLE NO. = 4
SOIL CONDITION = 3

SUBROUTINE RUOFF STRUCTURE INPUT RUNOFF CURVE = 70.0 TIME OF CONCENTRATION = 0.34
AREA = 0.52
COMPUTED CURVE NO. = 1

100-Yr.

TIME	DISCHG	PEAK TIMES	PEAK DISCHARGES	HYDROGRAPH, TZERO = 6.25	DELTA T = 0.25	PEAK ELEVATIONS	DRAINAGE AREA = 0.52
6.25	0.00	2.60	4.72	6.76	8.69	12.20	13.80
8.75	19.33	21.75	22.03	22.21	24.66	26.74	26.48
11.25	30.54	29.96	32.39	34.89	36.03	38.60	38.91
13.75	47.76	179.03	206.31	228.56	239.09	245.67	152.43
16.25	170.15	208.77	209.14	254.13	225.05	202.66	656.96
18.75	31.45	31.78	28.70	26.27	29.09	202.22	613.77
21.25	28.77	26.29	29.14	31.60	26.80	29.17	112.62
23.75	29.19	31.54	15.54	2.74	0.44	0.00	26.29
							31.63
							20.01
							26.35

TOTAL WATER, IN INCHES ON DRAINAGE AREA = 5.8254 CFS-HRS = 1954.98 ACRE-FI = 161.56

SUBROUTINE RESVOR SURFACE ELEVATION = 758.00

TIME	DISCHG	PEAK TIMES	PEAK DISCHARGES	HYDROGRAPH, TZERO = 6.25	DELTA T = 0.25	PEAK ELEVATIONS	DRAINAGE AREA = 0.52
6.25	0.00	0.04	0.15	0.33	0.57	1.19	1.56
8.75	758.00	758.00	758.00	758.01	758.02	758.03	758.06
11.25	2.92	3.48	4.07	4.64	5.24	6.57	7.21
13.75	758.12	758.14	758.17	758.19	758.22	758.25	758.30
16.25	9.28	10.27	11.33	12.46	14.63	16.85	18.76
18.75	49.63	51.09	52.71	54.17	55.79	57.47	58.97
21.25	759.22	759.28	759.34	759.50	759.67	760.13	759.72
23.75	351.82	359.29	355.06	356.16	297.69	277.47	244.65
26.25	762.02	762.04	761.98	761.91	761.85	761.78	761.67
28.75	165.31	143.41	124.47	100.91	97.47	92.50	85.43
31.25	761.34	761.23	761.13	761.05	760.98	760.92	760.82
33.75	72.00	67.08	62.73	59.15	55.99	52.88	50.77
36.25	760.68	760.63	760.57	760.53	760.49	760.44	760.41
38.75	55.66	55.60	55.54	55.44	55.33	55.22	55.10
41.25	760.33	760.30	760.27	760.22	760.16	760.11	760.05
43.75	54.42	54.23	54.05	53.55	52.94	52.33	51.74
46.25	759.65	759.54	759.43	759.30	759.35	759.33	759.26
48.75	44.41	40.20	45.17	42.33	39.60	37.17	34.64
51.25	759.21	759.18	759.13	759.07	759.03	759.98	758.90

TOTAL WATER, IN INCHES ON DRAINAGE AREA = 5.3354 CFS-HRS = 1740.53 ACRE-FI = 147.16

ENDCMP 1

END OF JOB
WATCH JOB

GRJ

TR20

WILKINS-WESTERN-SONDEREGGER

CALCULATIONS FOR

COMPUTED BY SEN DATE 10-10-53 SHEET NO. 1 OF 3
 CHECKED BY _____ DATE _____ JOB NUMBER 73,3005
 PROJECT Mo Sam Irrig

Principal Spillway Drop Inlet
 Rating - Weir

SCS-C21 = 10284

See sheet 8 of 16 SCS Plans $Q = CLH^3$

$L = \text{Length of weir} = 6' \times 2 = 12' -$

$C = 3.1$ SCS standard for this type

$$L \times C = 12 \times 3.1 = 37.2$$

Elev.	H	Q
-------	---	---

758.0	—	0
-------	---	---

Crest elev. on plans

758.2	.2	3.3
-------	----	-----

758.4	.4	9.4
-------	----	-----

758.6	.6	17
-------	----	----

758.8	.8	27
-------	----	----

759.0	1.0	37
-------	-----	----

759.2	1.2	49
-------	-----	----

759.4	1.4	62
-------	-----	----

759.6	1.6	75
-------	-----	----

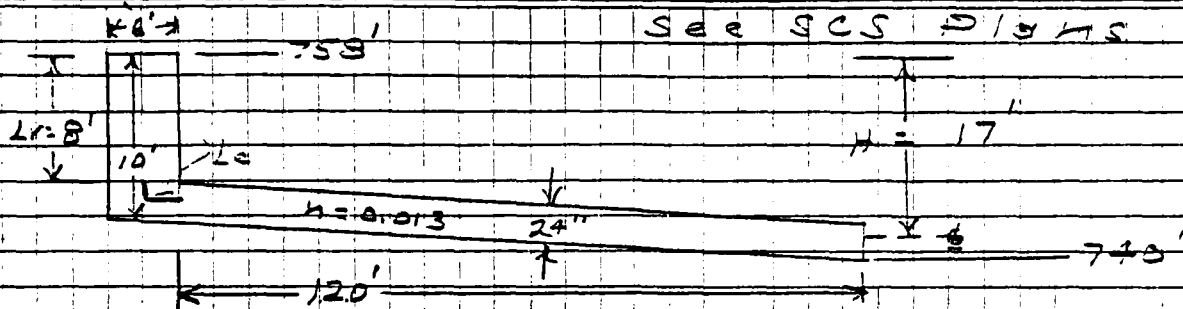
759.8	1.8	90
-------	-----	----

760.0	2.0	105
-------	-----	-----

P.S. Drop Inlet
Rating - Conduit

SCS-21 # 10284

See SCS Diagrams



From Appendix D - C of Engr. Hydr. Chav. of Reser.
Outlet works

$$\text{General Equation } Q = A \sqrt{\frac{2gh}{1 + \sum K}}$$

$$\text{where } 1 + \sum K = 1 + K_0 + K_b + \left[\frac{(2A_c)^2 L_r}{(A_r + A_c)} + \frac{(2A_c)^2 L_e}{(A_c + A_r)} + L_c \right] K_e$$

$$A_c = \text{Area of conduit} = \pi r^2 = \pi (1.0)^2 = 3.14 \text{ ft}^2$$

$$A_r = \text{Area of riser} = w \times b = 2 \times 6 = 12 \text{ ft}^2$$

$$A_c = A_r$$

$$L_r = 8' \quad L_c = 120' \quad L_e = \frac{L_r}{2} + \frac{L_c}{2} = 3 + 60 = 63'$$

From Engr. H.B. Sec. 5

$$K_0 = 0.5$$

$$K_b = 1.0$$

$$K_e = 0.124$$

$$1 + \sum K = 1.0 + 0.5 + 1.0 + \left[\frac{(2 \times 3.14)^2 \times 8}{(12 + 12)} + \frac{(2 \times 3.14)^2 \times 63}{(12 + 3.14)} + 120 \right] \cdot 0.124$$

$$= 2.5 + [0.543 + 6.38 + 120] \cdot 0.124$$

$$= 2.5 + [121.236] \cdot 0.124$$

$$= 2.5 + 1.503 = 4.0$$

$$Q_c = A_c \sqrt{\frac{2gh}{1 + \sum K}} \sqrt{h}$$

$$= 3.14 \sqrt{\frac{64.32}{4.0}} \sqrt{h}$$

$$= 12.59 \sqrt{h}$$

HOSKINS-WESTERN-SONDEREGGER
CALCULATIONS FOR

COMPUTED BY GGJ DATE 10/01/73 SHEET NO. 3 OF 3
CHECKED BY _____ DATE _____ JOB NUMBER 13300-1
PROJECT _____

Conduit Rating Cont'd.

SCS-21 = 10294

$$Q_c = 12.59 \sqrt{h}$$

Elev

h (+17.0')

Q

758.0

—

0

Crest Elev.

.2

.2

52

.4

.4

52

.6

.6

53

.8

.8

53

759.0

1.0

53

.2

1.2

54

.4

1.4

54

.6

1.6

54

.8

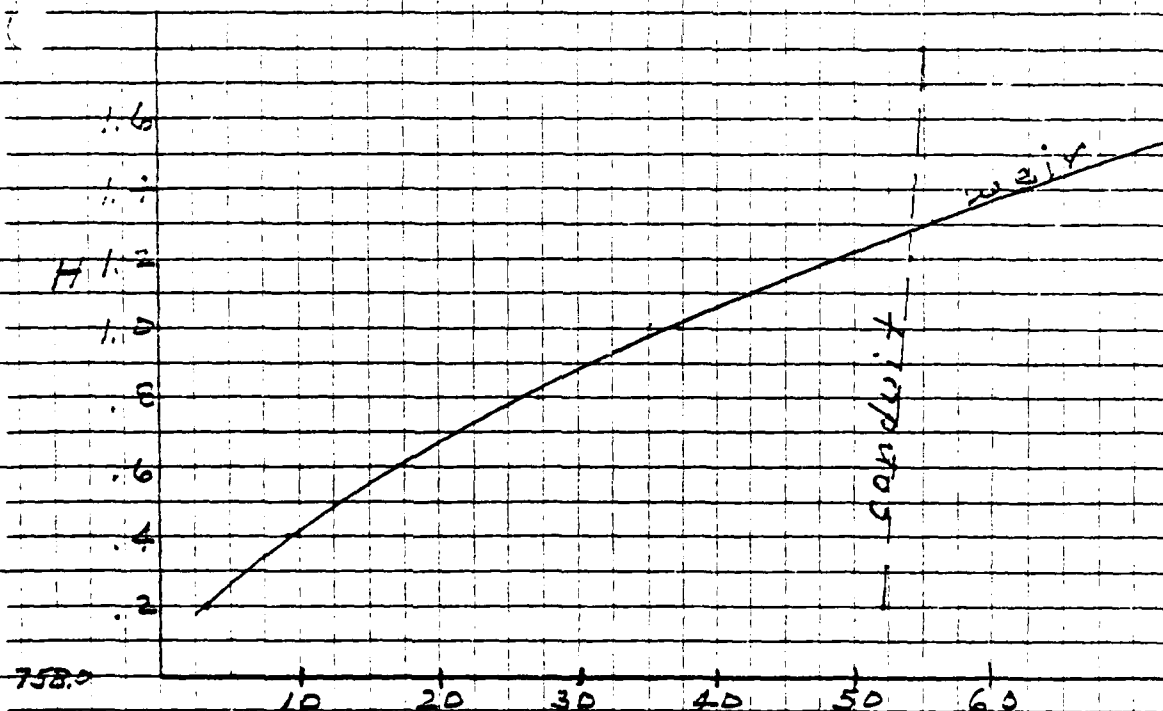
1.8

55

760.0

2.0

55



K SKINS-WESTERN-SONDEREGGER

CALCULATIONS FOR

COMPUTED BY ESJ DATE 10-11-78 SHEET NO. 3 OF 3
 CHECKED BY _____ DATE _____ JOB NUMBER 75-320-1
 PROJECT Mo Dam Insp

Flow over Dam Embank LaFayette Co - C-21

See TURT, BK 3, Chp 2-5

Q = 26 H^{1.5}

Stn	Dist	Elev	Top of Dam Elev	Depth	Velocity	Area	Q	Q
0	0	765.5	763.4	2.1				
+20	20				1.75	<.15	2.96	137
+40	40		764.1	1.4				
+60	60				1.20		2.87	302
+80	80		764.5	1.0				
+100	100				.9		2.80	239
+120	120		764.7	.8				
+140	140				.8		2.78	199
+160	160		764.7	.8				
+180	180				.85		2.79	219
+200	200		764.6	.9				
+220	220				.90		2.80	155
+240	240		764.6	.9				
+260	260				.45		2.67	10
+280	280	765.5	765.5	0				
								1261
0	0	766.0	763.4	2.6				
+20	20				2.25	<.15	3.00	202
+40	40		764.1	1.9				
+60	60				1.7		2.95	523
+80	80		764.5	1.5				
+100	100				1.4		2.91	482
+120	120		764.7	1.3				
+140	140				1.3		2.89	428
+160	160		764.7	1.3				
+180	180				1.35		2.90	455
+200	200		764.6	1.4				
+220	220				1.4		2.91	313
+240	240		764.6	1.4				
+260	260				.7		2.74	34
+280	280	766.0	766.0	0				
								2437

OSKINS-WESTERN-SONDEREGGER

 COMPUTED BY SS DATE 10-1-7 SHEET NO. 78/3095 OF 78/3095
 CHECKED BY _____ DATE _____ JOB NUMBER _____
 PROJECT _____

CALCULATIONS FOR

Total Rating

LaFayette-C-21

Elev	H	Weir	Cond.	Em. S.	Embank	Total
758.0	0	0	0	0		0
.2	.2	3.3				
✓ .4	.4	9.4		9.4		9.4
.6	.6	17				
✓ .8	.8	27		27		27
759.0	1.0	37				
✓ .2	1.2	49	54	49		49
✓ .4	1.4	62	54	54		54
.6	1.6		54			
.8	1.8		55			
✓ 760.0	2.0		55	55		55
✓ 760.5	2.5		56	56		56
✓ 760.7	2.7		56	73		73
✓ 761.0	3.0		56	99		99
✓ 761.5	3.5		57	194		194
✓ 762	4.0		58	340		340
✓ 763	5.0		59	744		744
✓ 763.4	Dam Crest		60	960		960
✓ 763.6	5.6		60			
764.1	6.1		61	1350	11	1361
✓ 764.5	6.5		61	1614	54	1668
764.7	6.7		61	1760	122	1882
✓ 765.0	7.0		62	1979	340	2319
765.5	7.5		62	2370	1261	3631
✓ 766.0	8.0		63	2772	2437	5209
766.5	8.5		64			
✓ 767.0	9.0		64			
✓ 768.0	10.		65			

 * Includes P.S. Flow
 (From Comp. Run)

**DAT
FILM**